GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MEMOIR 330

BANKS, VICTORIA, AND STEFANSSON ISLANDS, ARCTIC ARCHIPELAGO

R. Thorsteinsson and E. T. Tozer

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PREFACE

Banks, Victoria, and Stefansson Islands form a large, compact island group immediately north of the mainland of Canada. Although Banks and Victoria Islands were discovered early in the last century, Stefansson Island remained undiscovered until its separate existence was demonstrated by air reconnaissance flights in the immediate post-war period.

This report and map, based on a reconnaissance geological survey using light aircraft, show that rocks of Precambrian, Palæozoic, Mesozoic, and Cenozoic age are present on the islands. The stratigraphic and structural information is presented in sufficient detail for an evaluation of the mineral and petroleum possibilities of this very considerable area of Arctic Canada.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, June 1, 1961

Memoir 330—Banks Insel, Victoria Insel und Stefansson Insel im Arktischen Archipel. Von R. Thorsteinsson und E. T. Tozer

Beschreibt die Geologie dieser großen, kompakten Inselgruppe unmittelbar nördlich des kanadischen Festlands. Ausgedehnte präkambrische Ablagerungen sind von kambrischen (?), ordovizischen, silurischen und devonischen Gesteinen überlagert. Kreide-, Frühtertiär-, Spättertiär- und Pleistozängesteine sind diskordant zueinander und zu den älteren Gesteinen.

Мемуар 330 — Острова Бэнкс, Виктория и Стефанссон, Арктический архипелаг. Авторы: Р. Торстейнссон и Е. Т. Тозер.

Описание геологии этой большой, компактной группы островов находящейся непосредственно к северу от материковой части Канады. Докембрийские отложения широко распространены и покрыты кембрийскими?, ордовикскими, силурскими и девонскими породами. Меловые, раннее-третичные, позднее-третичные и четвертичные породы несогласно залегают друг на друге и на более древних горных породах.

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BANKS, VICTORIA, AND STEFANSSON ISLANDS, ARCTIC ARCHIPELAGO

Abstract

Banks, Victoria, and Stefansson Islands lie immediately north of the mainland and form the southwesternmost group of islands of the Canadian Arctic Archipelago. The islands include monotonous lowlands, hilly moraines, a low mountain range, and dissected uplands terminating in some places as spectacular sea-cliffs. Contrasting physiography reflects diversity of bedrock and structure. Five concordant rock successions separated by major unconformities are: (1) Metasediments of Precambrian age intruded by granodiorite. (2) A concordant sequence of six Precambrian formations comprising clastics, carbonates, gypsum, and anhydrite—extensively intruded by gabbro dykes and sills. (3) A concordant succession of Cambrian?, Ordovician, Silurian, and Devonian formations. (4) Three concordant Mesozoic and Cenozoic formations—the Isachsen, Christopher, and Eureka Sound Formations. The Isachsen Formation, mainly nonmarine, is Lower Cretaceous and has minor coal seams. The Christopher contains Albian ammonoids and is overlain by mainly nonmarine beds of the Eureka Sound Formation. (5) The Beaufort Formation, transgressive on the older successions, is unconsolidated sand and gravel of late Tertiary or early Pleistocene age. The Precambrian metasediments are characterized by steep dips, the younger Precambrian rocks are gently folded. Structures in the Palæozoic and younger rocks are mainly monoclinal and associated with the Holman Island syncline that crosses diagonally across Victoria Island south of Wynniatt Bay.

Résumé

Les îles Banks, Victoria et Stefansson se trouvent juste au nord du continent et forment le groupe d'îles le plus au sud-ouest de tout l'Archipel arctique canadien. Ces îles renferment des basses terres monotones, des moraines accidentées, une chaîne de montagnes peu élevées et un haut pays découpé qui se termine en certains endroits par des falaises d'aspect grandiose. La physiographie tourmentée reflète la diversité de la roche en place et de la structure. Il existe cinq successions concordantes de roches, séparées par d'importantes discordances de stratification. Elles sont: (1) des métasédiments d'âge précambrien envahis par de la granodiorite; (2) une succession concordante de six formations précambriennes qui se compose de sédiments clastiques, de carbonates, de gypse et d'anhydrite, et qui est pénétrée par une foule de sills et dykes de gabbro; (3) une succession concordante de formations cambriennes (?), ordoviciennes, siluriennes et dévoniennes; (4) trois formations mésozoïques et cénozoïques concordantes, à savoir la formation Isachsen, la formation Christopher, et la formation Eureka Sound (La formation Isachsen de nature principalement non marine remonte au Crétacé inférieur et contient quelques filons de houille. La formation Christopher renferme des ammonoïdes Albian et est recouverte par les couches principalement non marines de la formation Eureka Sound.); (5) la formation Beaufort, qui transgresse les limites des successions plus anciennes et qui se compose de sable et de gravier non consolidés qui datent de la fin du Tertiaire ou du début du Pléistocène. Les métasédiments précambriens se caractérisent par des pendages prononcés, alors que les roches précambriennes plus jeunes sont faiblement plissées. Au sein des roches paléozoïques et plus jeunes, les structures sont surtout monoclinales et se rattachent au synclinal de l'île Holman qui traverse l'île Victoria en diagonale au sud de la baie Wynniatt.

Chapter I

INTRODUCTION

Location and Field Work

Banks and Victoria Islands comprise areas of about 27,000 and 84,000 square miles, respectively, and lie immediately north of the mainland where they constitute the southwesternmost islands of the Arctic Archipelago. Stefansson Island comprises an area of about 1,800 square miles. It is situated directly north of Storkerson Peninsula, the extremity of northeastern Victoria Island.

This report describes a geological reconnaissance of the islands carried out in 1959 with the use of two Piper Super Cub aircraft. The aircraft were supplied by Bradley Air Services Limited of Carp, Ontario, and they were specially equipped with large, low-pressure tires that permitted landing on unprepared terrain. During the course of the field season an area of about 113,000 square miles was mapped on a scale of 16 miles to one inch. The Hudson's Bay Post of Holman provided the main base of operation for the Geological Survey party. Five subsidiary camps in widely separated regions of Banks and Victoria Islands were also occupied at different times during the course of field work. In preparation for field work in 1959, food, gasoline, and oil were sent to Holman in 1958 on the Hudson's Bay supply ship *Banksland*. The Survey party consisted of four geologists, a cook, a pilot-engineer, and a pilot. The Piper Super Cub aircraft were flown from Ottawa to the field. On June 21st the party was flown in a ski-equipped Otter aircraft from Yellowknife to Holman; on September 14th the party was picked up at Holman and flown back to Yellowknife in an Otter aircraft fitted with floats. Otter aircraft were chartered from Wardair Ltd., of Yellowknife.

R. L. Christie, J. G. Fyles, R. Thorsteinsson, and E. T. Tozer were engaged on this operation and gathered the data assembled in this report. J. G. Fyles has contributed the chapter on *Physiography*. The sections dealing with the Precambrian rocks have been written entirely by Thorsteinsson; Thorsteinsson and Tozer are jointly responsible for the writing of the remainder of this report.

About 460 landings were made on Banks, Victoria, and Stefansson Islands. Landing sites and flight lines are shown on Figure 1.

The year 1959 was the second year that the Geological Survey of Canada employed Piper Super Cub aircraft in geological studies in the Arctic Archipelago. In 1958, Thorsteinsson and Tozer (1959a)[1] conducted a reconnaissance survey of

[1] Names and dates in parentheses refer to publications listed under References.

the western islands in the Queen Elizabeth group using one Piper Super Cub aircraft. Details of the operation of light aircraft in the Arctic Archipelago are given by Thorsteinsson and Tozer (1959b).

Settlements and Accessibility

Sachs Harbour is the only settlement on Banks Island and several Eskimo families have resided there, more or less continuously, since 1929 (Manning, 1953, p. 36). An RCM Police detachment was established at Sachs Harbour in 1953, and in 1954 the Department of Transport established a weather station there.

Three settlements on Victoria Island predate the construction of the DEW Line sites. These are Holman at the north entrance to Prince Albert Sound and the site of a Hudson's Bay Post and a Roman Catholic mission (*see* Pl. I); Read Island, a Hudson's Bay Post only, off the southwestern coast of Wollaston Peninsula; and Cambridge Bay on the south coast of the island. Cambridge Bay has a Hudson's Bay Post, an RCM Police detachment, a Department of Transport weather station, an Anglican mission, and a Northern Service Officer of the

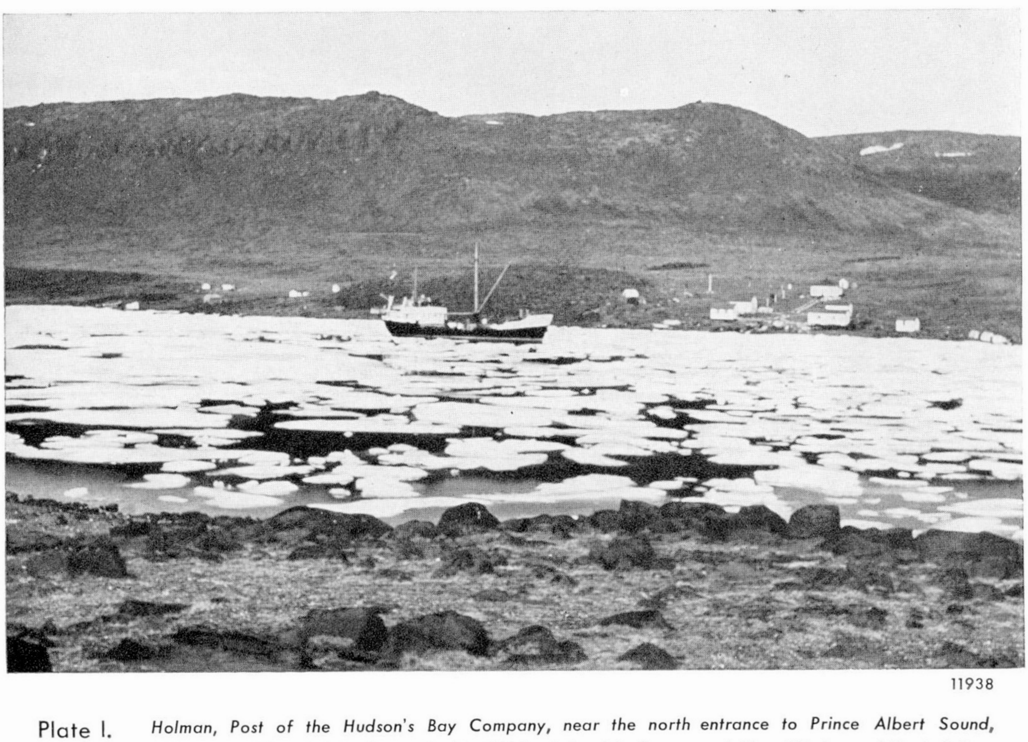

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Plate I. *Holman, Post of the Hudson's Bay Company, near the north entrance to Prince Albert Sound, southwestern Victoria Island; supply ship MV* Banksland *in foreground. The cliffs beyond the buildings are gabbro sills within the Kilian Formation.*

Department of Northern Affairs and National Resources. Cambridge Bay is also one of the main sites of the DEW Line. The total Eskimo population of Victoria Island is about 320. Besides Cambridge Bay, five other DEW Line sites are located along the south coast of Victoria Island from about Lady Franklin Point (west) to Sturt Point (east).

Stefansson Island has no settlements and there is no authentic record of any white man having visited it prior to the present investigation by the Geological Survey.

Landing strips at Cambridge Bay and at the other DEW Line sites are as follows (for detailed location see Canada Air Pilot, Directory Supplement 1962):

Site	Dimensions of Air Strips
	(feet)
Lady Franklin Point	100×4,950
Ross Point	75×1,750
Byron Bay	100×4,500
Cape Peel	75×1,550
Cambridge Bay	150×5,000
Sturt Point	75×2,700

The Meteorological Branch of the Department of Transport plans to begin construction of a landing strip at Sachs Harbour in 1962. Pacific Western Airlines operates biweekly passenger and express flights between Yellowknife and Cambridge Bay using Otter aircraft, and the town of Yellowknife provides the most convenient point from which to obtain access to the area by air. Charter aircraft are available there. The numerous lakes, especially on Victoria Island, permit access by float-equipped aircraft but the season is limited to about August and September. Aircraft equipped with skis have been used as late as the end of June, and light aircraft equipped with balloon tires have been used throughout the summer months, both by the Geological Survey party and the Army Survey Establishment, RCE. The south coasts of Banks and Victoria Islands may be reached by ship between August and October. The northern coasts are less accessible and have not been reached by conventional craft, although the RCM Police Schooner, *St. Roch,* under Henry Larsen (1945) navigated Prince of Wales Strait (from the east) in 1944. Icebreakers of the Royal Canadian Navy, the United States Navy, and the United States Coast Guard Service have navigated the waters surrounding Banks Island. In 1952-53, T. H. Manning circumnavigated Banks Island by canoe, on behalf of the Defence Research Board (Dept. of National Defence). Manning (1953, 1956) has described the difficulties encountered, and his account leaves little doubt that to repeat his remarkable achievement, which involved the first complete penetration of M'Clure Strait by boat, would not be an easy matter.

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Previous Geological Investigation

Although Banks and Victoria Islands are among the more accessible islands in the Canadian Arctic Archipelago, the first systematic geological work done on these islands was that of A. L. Washburn (1947). At various times between 1938 and 1941, Washburn conducted geological studies along parts of the south and west coastal regions of Victoria Island, and around De Salis Bay in south Banks Island. During the same period Washburn made additional observations on neighbouring regions of the mainland, King William Island, and other nearby but smaller islands. His excellent geological account is largely concerned with glaciation and geomorphology, but it contains also an exhaustive study of the literature; an integration of the resulting information with his own observations to form a picture of the regional geology; and a comprehensive bibliography. During the summer of 1939, Washburn was accompanied by P. E. Cloud whose observations on the geology of Victoria Island are included in Washburn's report. In addition Cloud (1942; 1945) has published on stromatolites from Victoria Island. Moreover, Ordovician fossils collected by Cloud and others, mainly on Read and Sutton Islands, form the basis of a report by Miller and Youngquist (1947). Y. O. Fortier found Silurian fossils at Greely Haven, east coast Victoria Island (*see* Fortier 1948).

Devonian fossils were discovered in northeast Banks Island by A. E. Porsild (National Museum of Canada) in 1949, and on Prince Albert Peninsula by T. A. Harwood (Defence Research Board) in 1953. The collections were submitted to the Geological Survey of Canada and these occurrences have been recorded by Fortier, *et al.* (1954, p. 2086).

In 1951, 1952, and 1953, T. H. Manning conducted expeditions to Banks Island for the Defence Research Board (Department of National Defence). The prime object of these expeditions was a study of the coastal areas of the island. As far as time permitted, a study of the fauna and flora was also made (*see* Manning, Hohn, and MacPherson, 1956; Manning and MacPherson, 1958). In 1951, the party travelled in CGMV *Cancolim* and visited the south and west coasts of Banks Island. During the following two summers Banks Island was circumnavigated by canoe. Manning and his party, although concerned essentially with geography, geodetic work, and biology, made numerous valuable observations on the geology of the island. Manning's narrative accounts (*see* Manning 1953; 1956) provide many topographical and geological notes including numerous illustrations of rock outcrops on Banks Island.

History of Exploration

Banks Island was first sighted, but not visited, by one of the most famous expeditions in search of a northwest passage. On August 7, 1820, as Lieutenant (later Admiral Sir) W. E. Parry of the Royal Navy, was making his second unsuccessful attempt in two seasons to sail his ships, the *Hecla* and *Griper,* westward around the Dundas Peninsula of southern Melville Island, Lieutenant F. W. Beechey climbed the cliffs to appraise the ice conditions that lay ahead. From the point of vantage gained, Beechey (*see* Parry, 1821, p. 237) "... discovered land from W.S.W. to S.S.W. at a great distance, and the loom of it also extending as far round to the eastward as a S. E. bearing". The following day Parry (op. cit., p. 238) viewed Beechey's newly discovered land. He states ". . . The weather being rather unfavourable, I had not so clear a view as Lieutenant Beechey, but I distinctly saw high and bold land from S75°W to S30°W ... This land, which extends beyond the 117th degree of west longitude, and is the most western yet discovered in the Polar Sea, to the northward of the American Continent, was honoured with the name of Bank's Land, out of respect to the venerable and worthy President of the Royal Society ...". Banks Island was first visited in 1850 when Captain Robert M'Clure (*see* Osborn, 1856, p. 101), in command of HMS *Investigator,* landed at Nelson Head, near the southern extremity of the Island. Between 1850 and the abandonment in 1853 of the *Investigator* in Mercy Bay on the north coast of Banks Island, M'Clure mapped the entire perimeter of Banks Island. For a comprehensive summary of the exploration of Banks Island the reader is referred to Manning (1956).

Although it is possible that Lieutenant Beechey may have also sighted Victoria Island at the same time he discovered Banks Island in 1829, the discovery of Victoria Island is generally accredited to Dr. John Richardson, an officer on Captain (later Sir) John Franklin's (1827) second expedition. The purpose of this expedition was to map and explore the north coast of the continent. After reaching the mouth of the Mackenzie River, Franklin divided his expedition into two parties. While Franklin personally undertook the exploration of the coast west of Mackenzie River, he assigned to Richardson the task of exploring easterly as far as Coppermine River. On August 4, 1826, Richardson's division encamped at a point on the mainland coast opposite the Wollaston Peninsula of Victoria Island. Before supper Lieutenant E. N. Kendall, Richardson's fellow officer, climbed up on high ground nearby and sighted what was later to be known as Victoria Island. Richardson (*see* Franklin, 1828, p. 253) writes, "As soon as supper was over, I also set out to enjoy the gratifying prospect, and from the extremity of the cape on which we were encamped, and which was named in honour of the Right Honourable Lord Bexley, I beheld the northern land running from north-north-west till it was lost in the horizon on a north 73° east bearing . . . This island, by far the largest one that was seen, either in the present voyage or on Captain Franklin's former Expedition, was named after that most distinguished philosopher Dr. Hyde Wollaston. The main shore had a direction nearly parallel to Wollaston Land . . . On the strait, separating the two shores, I bestowed the names of our excellent little boats, the Dolphin and Union." Peter Warren Dease and Thomas Simpson (*see* Simpson, 1843, p. 382), explorers for the Hudson's Bay Company, were the first white men to set foot on Victoria Island when they landed by boat at Cape Colborne in 1839 and sailed westerly along the south coast to a point a little beyond Byron Bay. From there they returned to the mainland. Simpson (op. cit., p. 296) had sighted Victoria Island the previous summer from a position on the Kent Peninsula and named the island after Queen Victoria. Later Dr. John Rae

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(1852) demonstrated the continuity of Simpson's Victoria Island and Richardson's Wollaston Land. Other well known Arctic explorers who figured in the completion of the coastal survey of Victoria Island include M'Clure (*see* Osborn, 1856; Armstrong, 1857; Collinson, 1889; Amundsen, 1908; and Stefansson, 1921.

The discovery of Stefansson Island is a fascinating story that is told by Diana Rowley (1952). Stefansson Island appeared on published maps for the first time after it had been charted from the air by reconnaissance flights that were made by the RCAF and USAF between 1946 and 1948. In 1952 the island was named by the Canadian Board on Geographic Names for the Arctic explorer, Vilhjalmur Stefansson. That such a large island, situated near the geographic centre of the Canadian Arctic Archipelago, should have remained undiscovered until the middle of the twentieth century came as a surprise. On the basis of published evidence it would appear that Storker Storkerson had come closest of any of the earlier explorers to discovering Stefansson Island when he was a member of the Canadian Arctic Expedition of 1913-18, under the command of Vilhjalmur Stefansson (*see* Stefansson, 1921). In 1915 and again in 1917, Storkerson made unsuccessful attempts to map the remaining unknown stretch of coast-line on northeastern Victoria Island. This unknown coast lay between Wynniatt Bay and Cape Nansen on the north and east coasts of Victoria Island, respectively. Storkerson's base of operation was the expedition's ship *Polar Bear* that wintered on the west coast of Victoria Island. At the end of his outgoing journey, on July 13, 1917, Storkerson reached the northern extremity of the northeastern peninsula of Victoria Island. From this point Storkerson saw, but did not visit, two small islands which he named Kilian Island and Elvina Island. The seemingly inexplicable fact that Storkerson could have observed these islands and not have seen Stefansson Island prompted Diana Rowley to study Storkerson's diary which is in the Public Archives of Canada. There Mrs. Rowley made the startling discovery that Storkerson on July 13, 1917, did in fact see and map an island in the present position of the western extremity of Stefansson Island. To this island Storkerson gave the name Leffingwell after Ernest de Koven Leffingwell, one of the joint leaders of the Leffingwell-Mikkelsen Arctic Expedition of 1906-07 on which Storkerson had served. That Storkerson's Leffingwell Island should never have found its way onto published maps remains a mystery.

Acknowledgments

Thanks are expressed to P. D. McTaggart-Cowan, Director of the Meteorological Branch, Department of Transport, for permission to use the Sachs Harbour weather station as a base of operation during the geological investigation of southern Banks Island. Special thanks are offered to J. W. Stanners, manager of the Hudson's Bay Post at Holman, and to Mrs. J. W. Stanners, for many courtesies extended to members of the Geological Survey party during their stay at Holman. Acknowledgment is also made to the following persons who assisted in fossil identifications and in supplying information on ages and correlations: T. E. Bolton, M. J. Copeland, J. A. Jeletzky, D. C. McGregor, D. J. McLaren, and G. Winston Sinclair. The writers also acknowledge the use of field notes on bedrock features made by R. L. Christie and J. G. Fyles. Numerous discussions with these officers have assisted the writers in compiling this memoir.

Chapter II

PHYSIOGRAPHY

by *J. G. Fyles*

The diverse physiographic regions making up Banks, Victoria, and Stefansson Islands are outlined in Figure 2. They include extensive monotonous lowlands, massive hilly moraines, a low mountain range, and dissected uplands bordered in places by spectacular sea-cliffs. These contrasting regions reflect the diverse lithology and structure of the bedrock, as well as regional differences in Pleistocene and Recent history. The close relation of the physiography to the bedrock is evident from the similarity of Figure 2 to the geological map (Map 1135A).

The landscape of Victoria and Stefansson Islands and an eastern strip of Banks Island, like that of adjoining parts of the continental mainland, is characterized by abundant fresh glacial landforms and by flights of marine strand lines. The glacial features relate to the last ("classical" Wisconsin) glaciation and the strand lines to submergence during and following glacial retreat (*see* Craig and Fyles, 1960). The topography of the western and greater part of Banks Island, on the other hand, is dominated by the effects of fluvial erosion and deposition. This area probably lies beyond the northwestern boundary of the last ice-sheet (op. cit.), and, although it contains deposits of one or more (earlier?) continental glaciations, glacial landforms are much less obvious than in the region to the east. The fluvial dissection of Banks Island reflects both the softness of the underlying rocks and the long sequence of events that has produced the landscape. Clearly defined raised marine strand lines have not been found in western Banks Island, but doubtful emergent shore features occur in a few places. Drowned estuaries at the mouths of rivers point to recent encroachment of the sea over the land.

Lowlands of Victoria and Stefansson Islands. Most of Victoria Island and all of Stefansson Island comprise lowland areas underlain, for the most part, by gently dipping to flat-lying dolomite, and minor limestone, sandstone, and shale of early Palæozoic age. Much of this lowland region lies within 500 feet of sea-level and the highest ground is about 1,000 feet above sea-level. Local relief ranges from a few tens of feet to about 200 feet. The land is dotted by innumerable lakes and in general the drainage is disorganized.

The landscape of the lowlands is dominated by glacial landforms, especially when seen from the air. Fields of drumlins and drumlinoid ridges impart a regular but complex 'grain' to the country (*see* Pl. II). Patches and belts of rough, hilly morainal topography with relief of up to 200 feet contrast with

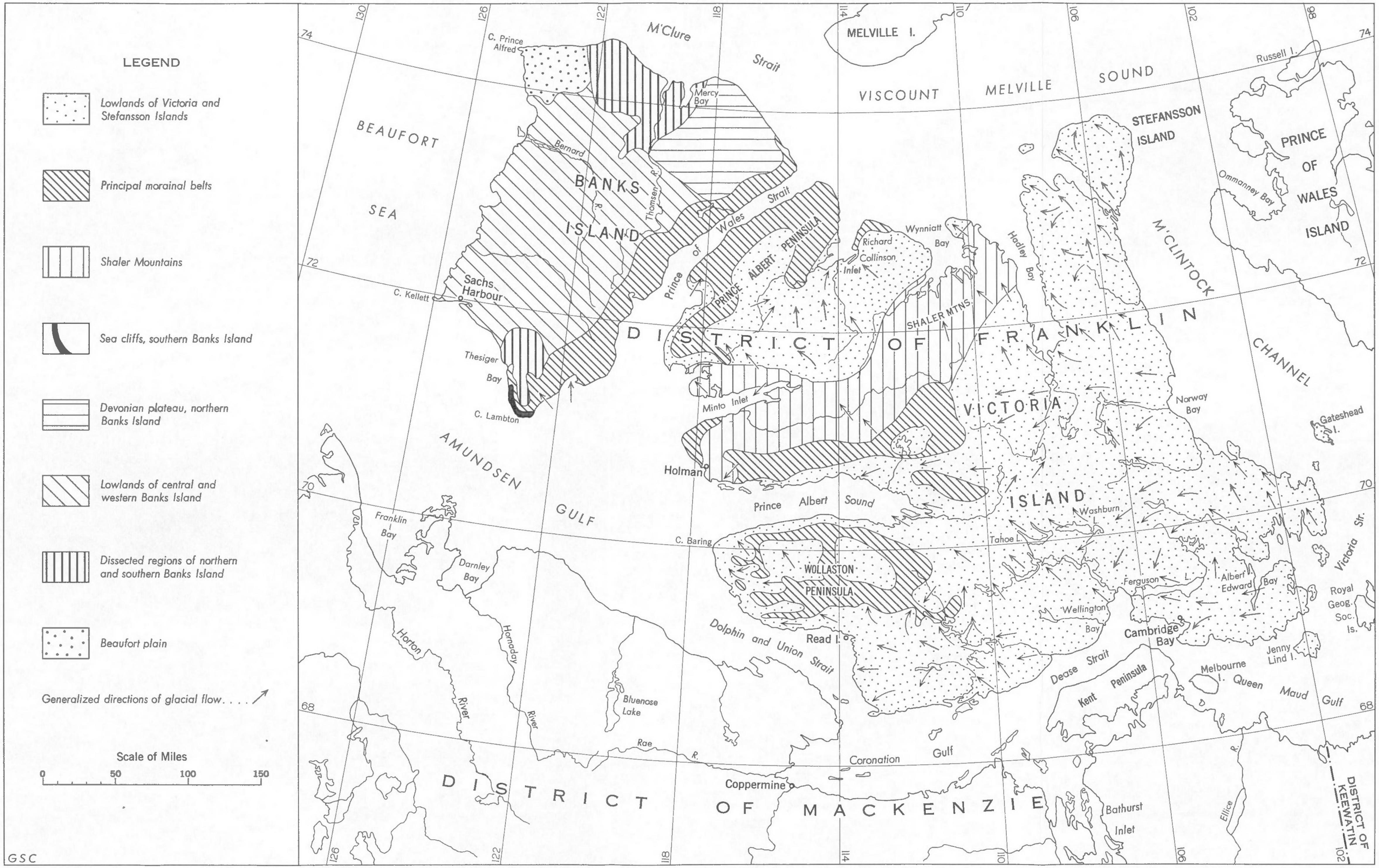

FIGURE 2. Physiographic regions of Banks, Victoria and Stefansson Islands

Plate II. *Western Stefansson Island. The interior of the island is largely covered by ground moraine, with northwesterly aligned drumlins. Small outcrops of Palæozoic dolomite (map-unit 10b) occur along the west coast and in the deeper stream valleys. (RCAF photo)* the smoother drumlinoid areas. The largest morainal belts, generally with greater relief, are set apart as a separate physiographic unit (*see* below). Gravelly and sandy esker complexes form branching river-like systems that commonly parallel the drumlinoid trend but locally diverge markedly from it. Esker ridges and associated kame hills constitute the most prominent eminences in the flatter parts of the region. Mount Pelly at Cambridge Bay (*see* Washburn, 1947) constitutes the junction of two esker systems. Numerous remarkably fresh, shingly to sandy marine beaches extend up to about 600 feet above present sea-level on southern Victoria Island and to about 200 or 300 feet in the western and northern parts of the island. They are best developed in the vicinity of rock outcrops and eskers, which constitute generous sources of gravelly material.

Despite the dominant role of the constructional landforms described above, the surficial cover of unconsolidated deposits is generally thin. Some areas of drumlinoid, morainal, and beach topography are surfaced by thin rubbly drift derived largely from the local bedrock and only partly covering the bedrock. Parts of the region are essentially ice-scoured bedrock plains surfaced by broken outcrops and felsenmeer. More prominent rock outcrops occur mainly along present and former seashores and along some rivers. Most rivers, however, have accomplished surprisingly little erosion and merely follow depressions in the topography left by the retreating ice-sheet.

Morainal belts. Large morainal belts occupy an eastern coastal strip of Banks Island and the coastal parts of western Victoria Island. Those of Victoria Island are arbitrarily set apart from the lowlands—which include patches of similar topography—because of their extent and continuity and because they commonly display greater local relief and summit altitude. These moraines were formed during the last ("classical" Wisconsin) glaciation. On the other hand, smaller morainal belts (not shown on Fig. 2) adjoining the southwest coast of Banks Island between Cape Lambton and Sachs Harbour and along the west part of north coast of Banks Island may have been built during the same glaciation or may be partly or entirely older.

The morainal belts consist of thick, varied drift that is generally heaped up into steep-sided hills and depressions. Some morainal areas, however, consist of broad smooth hills and ridges. Characteristically the moraines have local relief of several hundred feet with summits 800 to 1,500 feet above sea-level. Meltwater channels, short eskers, and patches of lake silt are common. Locally raised beaches are a prominent component of the landscape but are rare and obscure within some of the morainal areas known to have been submerged by the sea. Bedrock outcrops occur in only a few places within the morainal belts and are largely confined to modern and former shoreline escarpments and to modern and abandoned river channels.

The most prominent and striking morainal topography within the area is displayed by the morainal belts on Wollaston Peninsula of southwestern Victoria Island. These exceedingly rough areas comprise a bewildering array of conical, ridge-like, and irregular hills that look like ranges of mountains when viewed from a distance. They constitute the highest part of the peninsula and culminate in Mount Bumpus, a conical bouldery gravel hill 700 feet high with summit altitude of about 1,800 feet. A belt of narrow irregular morainal ridges outlining a well-marked boundary of the ice-sheet during deglaciation extends along the southern margin of the southern morainal belt for about 120 miles. These moraines of Wollaston Peninsula, like most moraines in the area, consist largely of stony loamy till and bouldery stony gravel ranging up to several hundred feet in thickness.

The morainal belts on eastern Banks Island and on Prince Albert Peninsula of northwestern Victoria Island include smooth rolling ridged topography and areas of rough topography. These belts are underlain in part by thick stony glacial deposits but also include areas of thin glacial materials capping well-sorted, regularly stratified gravels, sands, and silts. Complexly intermingled glacial, lacustrine, and marine deposits comprise the northern part of these morainal zones. Broad, relatively smooth ridges several hundred feet high parallel the shores of Prince of Wales Strait, Viscount Melville Sound, and Richard Collinson Inlet, and numerous large north-draining meltwater channels trend in more or less the same direction. The moraine crests stand 400 to 1,500 feet above the adjoining arms of the sea throughout much of their length, and the Banks Island moraine constitutes the principal drainage divide of the Island. At Durham Heights (altitude area 2,500 feet), the highest point on Banks Island, the moraine is superimposed on a high area of Precambrian rocks.

Shaler Mountains, Victoria Island. The Shaler Mountain belt, extending northeasterly across Victoria Island from Amundsen Gulf to Hadley Bay, consists of high plateaux and ridges, steep escarpments, linear valleys, mesas, buttes, and cuestas that coincide with the outcrop area of late Precambrian sedimentary and volcanic rocks and sills (*see* Pls. VI, X, XI, XII). Ridges, escarpments, and valleys characteristically parallel the strike of the bedrock. Ridges and plateaux are generally capped by basalt flows or diabase sills while intervening valleys have been cut into the less-resistant sedimentary rocks. Ridge crests are typically 1,000 to 1,500 feet above sea-level and the lava plateau in the interior of the belt reaches a maximum altitude of about 2,500 feet.

Fresh glacial landforms are present throughout the mountain belt but are dwarfed by the larger rock-controlled elements of the landscape. Trends of glacial-flow features, eskers, and meltwater channels are controlled in part by the bedrock topography. In places differential hardness of the rocks has given rise to striking crag-and-tail hills. Raised marine beaches are locally present but due to the steepness of the topography, they only occur adjacent to the present shore. Steep, amphitheatre-like valleys simulate cirques but appear to have resulted from mass wasting, nivation, and fluvial erosion of the flat-lying rocks and have yielded no evidence of former local glaciers. Permanent snowbanks occur in sheltered places but true glaciers are lacking. Large pro-talus ramparts form miniature moraine-like ridges below some cliffs.

Sea-cliffs, Southern Banks Island. The late Precambrian rocks that form the Shaler Mountains outcrop on the southern tip of Banks Island as a series of spectacular sea-cliffs extending from Nelson Head westward and northwestward to the mouth of Atitok River (*see* Pls. VII-IX). The cliffs are about 1,400 feet high at Nelson Head but become progressively lower to the west and northwest. This distinctive physiographic region is bounded inland by a less steep escarpment up to 1,000 feet high consisting of soft Mesozoic strata and morainal debris.

Devonian Plateau, Northeastern Banks Island. Northeastern Banks Island is a plateau bordered on the north by remarkably continuous, steep sea-cliffs 500 to 800 feet high, and cut by steep-walled commonly V-shaped narrow valleys (*see* Pl. XXIII). The plateau is underlain by gently dipping Devonian rocks, mainly alternating sandstone, siltstone, and shale, which are responsible for the distinctive form of the valleys and cliffs. The plateau surface is a desolate plain 1,000 to 1,500 feet above sea-level. It is characteristically surfaced by rock rubble that is derived from bedrock, and in places by thin, nondescript glacial debris. The northern and western parts of the plateau consist of a network of narrow, commonly flat-topped ridges and steep-sided narrow canyons several hundred to 1,000 feet deep. Inland, to the south, the valleys become smaller and shallower and are replaced headward by shallow draws in the rubble and drift that mantle the plateau surface. In the interior part of the plateau the distinctive canyon-form of the valleys is maintained wherever they have been eroded into the Devonian rocks, but the upland areas between the valleys are similar to and merge with the interior plain to the southwest.

Patches of thick glacial drift and apparently of drift overlying nonglacial deposits locally stand above the even surface of the plateau interior. Gravelly to silty terraces stand one or two hundred feet above the floors of some of the valleys near their mouths, and dissected bodies of lacustrine silt lie within the valleys of Parker River and some of its neighbours. Some of the valleys in the eastern and southern part of the plateau appear to have been formed or modified by glacial meltwater.

Lowlands of Central and Western Banks Island. A low plain of gently rolling hills, shallow valleys, and alluvial flats and benches occupies most of central and western Banks Island (*see* Pl. III). The plain is largely within 500 feet of sea-level but its southeastern, eastern, and northeastern parts rise gradually to elevations of 800 to 1,000 feet. Local relief ranges from a few tens of feet to 300 feet. The plain is underlain by weakly consolidated sandstone and shale of the Eureka Sound Formation. This formation is overlain by gravel and sand of the Beaufort Formation, various deposits of glacial origin that probably relate to more than one pre-Wisconsin (?) glaciation, interglacial and postglacial silt and peat, and alluvium of both present and former rivers. These surficial deposits range up to about 200 feet in thickness, but in many parts of the region they are represented by only a few inches or feet of gravelly material formed by mass wasting of the above deposits.

Plate III. *Lowlands of western Banks Island, looking west from the prominent bend of Bernard River. Local relief is 100 to 200 feet. Interstream areas are largely surfaced by gravelly glacial and Beaufort deposits. Modern and abandoned river valleys are cut through these surficial deposits (generally only a few feet to a few tens of feet thick) and into the underlying sands of the Eureka Sound Formation. Outcrops of these sands appear as white patches on the valley walls (arrows). Valley floors are partly covered by peat and dotted with innumerable shallow tundra ponds. (RCAF T481R-167)*

The region is drained by a series of long, west-flowing rivers that rise in the moraine only a few miles from the east coast. The main rivers occupy exceedingly broad shallow valleys floored by gravelly and sandy alluvium and swampy tundra with large polygons and rounded shallow ponds. In places gravelly terraces stand a few feet to a few tens of feet above the valley floors. The lower reaches of the rivers are strikingly braided but the upstream portions are partly braided and partly meandering. The large rivers enter the Beaufort Sea through broad swampy deltas which barely fill the mouths of the valleys. Estuaries at the mouths of small rivers carrying less sediment have clearly been drowned by the sea. Headlands along the west coast bear wave-cut cliffs up to 150 feet high, whereas the lower intervening coast is fringed by sandy to gravelly spits and bars.

For a few miles inland from the coast, the interstream parts of the lowland plain are characterized by gently rolling, degraded, but almost undissected ground-moraine topography. Small local streams flow on the surface of the plain or in shallow draws and are disorganized to subdendritic in pattern. The fairly numerous ground-moraine ponds are smoothly rounded in outline as though substantially modified by solifluction. The surface material is typically boulder-strewn, gravelly colluvium apparently formed from the intermingling of glacial deposits with the underlying Beaufort gravel and/or sandy to shaly bedrock.

In contrast, the interior, major part of the lowland plain is dissected by a dendritic network of river valleys and gullies that has reduced the region to a stage of late youth and locally even to early maturity. Typically the valleys and gullies are only a few feet to a few tens of feet deep. Most of the surface remaining between the valleys is similar to the undissected parts of the lowland adjacent to the coast and probably has had a similar history. However, parts of the dissected surface are high-level fluvial benches on which evidence of glaciation has not been found. The valleys and gullies are mostly broad and shallow and only locally V-shaped. Although some are being actively eroded by modern streams, many are floored by peat, contain lakes, or are occupied by underfit streams. The time of erosion of most of the abandoned and underfit valleys is not known. Some however have been cut by meltwater emanating from glacial ice along the east Banks Island moraine and others by meltwater from an (earlier?) ice-sheet that extended across the interior of Banks Island; alluvial plains are associated with the meltwater channels of both generations. Some of the dissection, however, is much older and appears to have preceded glaciation, but whether it is interglacial or preglacial is not known.

Dissected Regions of Northern and Southern Banks Island. The high margins of the Banks Island plain are bordered on the northeast and southeast by deeply dissected regions drained by rivers flowing to the nearby north and southwest coasts. In both the northern and southern dissected regions the rolling plain occurs as upland remnants about 1,000 feet above sea-level, cut by a dendritic complex of steep-sided valleys and gullies a few hundred to 1,000 feet deep.

The southern dissected region coincides with the drainage basins of Rufus, Atitok, and Masik Rivers and the upper part of Sachs River. Most of the region is in a stage of middle to late youth, with substantial upland areas remaining between valleys. The valleys characteristically have steep sides and flat floors although some are V-shaped. Most are narrow but the valley of Masik River is several miles wide for about 25 miles from its mouth. The upland surface is underlain by varied glacial and nonglacial surficial deposits, a few feet to more than 200 feet thick, which rest in turn upon flat-lying shales and sands of Cretaceous and Tertiary age. An early glaciation or glaciations appear to have preceded much if not most of the dissection, whereas a younger glaciation took place after the valleys and coastal escarpment had reached almost their present form.

The northern dissected region, extending some 20 to 40 miles south from the north coast between Mercy Bay and Colquhoun Point, grades from a youthfully dissected upland in the south and west to lowlands surmounted by isolated residual hills closer to the coast (*see* Pl. VI). Several erosion cycles may be represented as dissection has modified various gravel-capped benches and less regular surfaces lower than the main upland. Most of the region is underlain by gently dipping, weakly consolidated Cretaceous to early Tertiary sediments that are highly susceptible to fluvial erosion, and locally carved into distinctive badlands topography. Where the upland surface remains, the bedrock is capped by a few tens of feet of Beaufort gravel and sand, in turn overlain by colluviated glacial deposits. Some valleys are narrow and youthful whereas others are broad and mature. Gravelly terraces border the modern floors of many of the valleys and some terraces cross present drainage divides. A few valleys are occupied by underfit streams or do not carry any through drainage. Some of the present rivers meander but many, particularly in the western sandy part of the region, are braided. In the eastern part of the region, valleys and low ground bear evidence of having been modified by glacial ice, whereas in the western part, much of the valley cutting appears to have taken place since glaciation. Clear evidence of more than one glaciation, however, has not been found in this region.

Beaufort Plain of Northwestern Banks Island. Northwestern Banks Island is a fluvial plain, some 20 miles wide from north to south and 40 miles from east to west, underlain by thick gravels and sands assigned to the Beaufort Formation (*see* Pl. IV). This plain is separated from M'Clure Strait on the north by a narrow belt of hilly, apparently morainal topography, and is bordered on the south and east by the lowlands of central and western Banks Island. The Beaufort plain rises gradually from sea-level at the west coast to an altitude of about 800 feet at its eastern boundary. It is drained by more or less parallel, west-flowing, consequent major rivers and by dendritically arranged tributary streams. As seen in air photographs, this drainage pattern is remarkably similar to that characterizing the Arctic Coastal Plain (also underlain by Beaufort Formation) in the Queen Elizabeth Islands to the north.

River valleys are cut a few feet to 500 feet below the plain surface. The larger valleys range up to 3 miles in width and characteristically have flat floors and steep

Plate IV. *Looking north over plain developed on Beaufort Formation in northwestern Banks Island. M'Clure Strait in background; large braided stream in foreground is Ballast Brook. (RCAF T517R-74)* walls. Some, however, are asymmetrical in cross-section, with steep undercut north walls, narrow floors, and south walls rising gradually as broad indistinct steps to merge with the plain surface. Many of the rivers are strikingly braided, particularly in their lower reaches. Rivers flowing to the west coast enter the sea through broad, swampy, deltaic plains that stand only slightly below the adjoining parts of the ancient plain. Those flowing to the north coast do so through rather narrow valleys 100 feet or more deep that pass from the Beaufort plain northward through the coastal morainal belt. Large, shallow abandoned valleys just south of the morainal belt appear to be ancient west-draining courses of the rivers that now flow to the north coast. Smaller, northward-draining abandoned channels are locally, at least, still older than those draining west.

The valleys are separated by broad areas of flat plain, and dissection has only locally progressed beyond early youth. The plain surface is remarkably uniform and completely free of lakes. It is underlain by wood-bearing pebble gravel that appears to be the undisturbed uppermost part of the Beaufort Formation. It is more probable, nonetheless, that much of the near-surface gravel is secondary, reworked Beaufort material that has been redeposited by younger rivers. The plain has not yielded clear evidence of having been overridden by glacial ice, even though the Beaufort Formation has undergone glaciation in the adjoining country to the north, south, and east. Whether the plain has indeed escaped glaciation, or whether the evidence of former glacial cover has been obscured by subsequent fluvial reworking of the surface materials is not known.

Chapter III

BEDROCK GEOLOGY

Rocks of Precambrian, Palæozoic, Mesozoic, and Cenozoic ages are represented in the map-area. Most of the rock exposed is of sedimentary origin, but metamorphic, intrusive, and volcanic rocks also occur. The layered rocks within the map-area may be grouped into five, structurally conformable successions separated from one another by major unconformities. The salient characters of these successions, together with those of the intrusive rocks, are given below.

1. A formation of metasediments (map-unit 1), consisting chiefly of quartzite, represents the oldest rocks in the map-area. This formation is of Precambrian age.

Map-unit 1 is intruded by a small body of granodiorite (map-unit 2) that is exposed over an area of about 2½ square miles on the west side of Hadley Bay, and on a nearby small island.

2. A concordant sequence of six Precambrian formations rests with angular unconformity on map-unit 1. The five oldest formations of this sequence are herein named the Shaler Group. They are formed mainly of limestone, sandstone, siltstone, shale, and evaporites. The approximate total thickness of the Shaler Group is 11,000 feet. The Natkusiak Formation, which consists of basalt flows and pyroclastic sediments, overlies the Shaler Group disconformably. This formation attains a thickness of about 1,000 feet and constitutes the youngest layered Precambrian formation within the map-area. The Shaler Group and overlying Natkusiak volcanic formation are well exposed on the Minto Arch, which extends northeasterly across Victoria Island, from Amundsen Gulf to Hadley Bay. Isolated exposures of Precambrian rock occur on southern Victoria Island and at the south tip of Banks Island. These isolated Precambrian rocks are tentatively assigned to the basal formation of the Shaler Group (Glenelg Formation).

The principal exposures of the Shaler Group and all exposures of the Natkusiak Formation occur in the gently folded, but large regional structures of the Shaler Mountains. There these rocks form a belt that extends northeasterly across Victoria Island. Rocks, outside of the Shaler Mountains, that are tentatively correlated with the oldest formation of the Shaler Group (i.e. the Glenelg Formation) outcrop in southern regions of Banks and Victoria Islands. In the latter region the Glenelg Formation appears to represent sub-Palæozoic topographic highs that are exposed as inliers.

Precambrian rocks, especially the Shaler Group, are intruded by numerous sills and fewer dykes of gabbro. These sills and dykes do not intrude the Palæozoic rocks; they are, therefore, regarded as the youngest of the Precambrian rocks.

3. An apparently concordant succession of Cambrian?, Ordovician, Silurian, and Devonian rocks lies with angular unconformity on the rocks of Precambrian age. Broadly speaking, the Palæozoic rocks form gently inclined homoclinal sequences that dip away from the structurally elevated Minto Arch. Throughout much of southern and eastern Victoria Island the Palæozoic rocks are virtually horizontal. There are thus three broadly defined homoclinal sequences of Palæozoic rocks: northwesterly dipping Cambrian?, Ordovician, Silurian, and Devonian rocks that occupy northwestern Victoria Island and northeastern Banks Island; northerly dipping Ordovician? to Silurian rocks that occupy all of Stefansson Island; and the horizontal, easterly and southeasterly dipping Cambrian?, Ordovician, and Silurian rocks that occupy much of Victoria Island southeast of the Shaler Mountains.

The oldest Palæozoic formation is map-unit 10a. It is sporadically developed and is composed principally of sandstone, shale, siltstone, and dolomite, much of it red or green and attaining maximum thickness of about 400 feet. Map-unit 10a appears to occupy topographic lows on the Precambrian floor. It is provisionally dated as Upper Cambrian on the basis of chitinoid brachiopods.

Map-unit 10b is composed mainly of dolomite. In some areas it rests with gradational contact on map-unit 10a; elsewhere it lies directly on Precambrian rocks. Map-unit 10b outcrops over about three quarters of both Victoria and Stefansson Islands. It ranges in age from Middle Ordovician to Middle Silurian. There are, however, reasons for suggesting that this formation may be as old as Upper Cambrian or Lower Ordovician. The thickness of map-unit 10b is roughly estimated as 3,000 feet.

The Read Bay Group overlies conformably map-unit 10b. Good exposures of this group are found on the north coast of Stefansson Island where three formations have been outlined. These are: a lower limestone and dolomite formation that bears the characteristic *Atrypella* fauna; a middle graptolitic shale that is of lower Ludlovian (Upper Silurian) age; and an upper dolomite formation which has not yielded fossils. The aggregate thickness of this group on Stefansson Island is about 675 feet. The Read Bay Group is present also on Prince Albert Peninsula of northwestern Victoria Island, but there it is mostly covered by Pleistocene deposits. The Read Bay Group of this map-area yielded only Upper Silurian fossils, but Middle Silurian rocks may be included in the lower formation. The upper contact of the Read Bay Group is not exposed. The next younger rocks are Middle Devonian. The contact between the Silurian and Devonian rocks has not been seen and is probably concealed by glacial deposits.

The lower part of the Middle Devonian sequence is referred to the Blue Fiord Formation. Exposures of this formation are confined to the northwestern coast of the Prince Albert Peninsula and the adjacent Princess Royal Islands. The base of the formation is apparently concealed beneath the thick Pleistocene deposits of Prince Albert Peninsula, and the top is apparently hidden beneath the waters of Prince of Wales Strait. The Blue Fiord Formation consists of limestone with minor dolomite and shale. It is moderately rich in fossils. Accurate data are not available on the thickness of Blue Fiord beds, but they are assumed to be several hundred feet thick. It is possible that one or more formations lie stratigraphically between the Read Bay Group and the Blue Fiord Formation on Prince Albert Peninsula, but are hidden beneath the thick Pleistocene deposits of this region.

The youngest Palæozoic exposures are assigned to the Melville Island Formation. Extensive exposures of this formation occur throughout the plateau area of northeastern Banks Island; south of the plateau a few small exposures project through the Pleistocene cover. The Melville Island Formation is also exposed as inliers in the structurally elevated Cape Crozier area, at the north cape of Banks Island. This formation consists mainly of sandstone, with lesser siltstone and shale. Limestone and thin coal seams occur in some areas. The limestone forms spectacular reefs in the upper part of the formation, south of Mercy Bay. Marine Upper Devonian fossils were taken from these reefs and from sandstone beds adjacent to the reefs. Poorly preserved fossils, possibly of Middle Devonian age, were collected from stratigraphically lower beds. The typical rocks of this formation, on Melville Island, contain both Middle and Upper Devonian faunas and it is probable that Middle Devonian beds also occur on Banks Island. Parts of the Melville Island Formation were certainly deposited under marine conditions, but other parts were probably laid down above the strand line.

4. A structurally conformable sequence of three formations, ranging in age from Lower Cretaceous to early Tertiary forms the next succession. These formations occupy a large part of Banks Island and rest with transgressive unconformity on Precambrian and Palæozoic rocks. Although largely obscured by late Tertiary and Pleistocene deposits, the Lower Cretaceous and early Tertiary sediments appear to occupy a broad basin, the axis of which strikes and plunges northwesterly through about the geographic centre of Banks Island.

The oldest formation is the Lower Cretaceous Isachsen Formation, whose thickness ranges from about 200 to 300 feet. This formation consists mainly of nonmarine, weakly consolidated to unconsolidated sandstone, conglomeratic sandstone, and minor thin coal seams. The Isachsen Formation on Banks Island has not yielded diagnostic fossils. The indentification of this formation is based on its stratigraphic position below the Christopher Formation and its lithologic similarity to the Isachsen Formation as developed in islands north of Parry Channel.

The Christopher Formation rests with gradational contact on Isachsen beds throughout most of the area. In the vicinity of Cape Crozier, near the northern extremity of Banks Island, Isachsen beds are absent and the Christopher Formation appears to rest directly on Devonian rocks. The Christopher Formation consists of dark marine shale and minor sandstone. Large septarian nodules up to 12 feet in diameter and small "hedgehog" concretions of calcite also characterize this formation. The thickness of the Christopher is estimated to vary between 1,000 and 1,200 feet. Albian (late Lower Cretaceous) ammonoids have been collected from this formation on Banks Island.

A sequence of beds that consist mainly of nonmarine sediments rest with apparently conformable yet abrupt contact on the Christopher Formation. These beds are tentatively assigned to the Eureka Sound Formation on the basis of stratigraphic position and lithological correlation. Three members are recognized in the Eureka Sound Formation on Banks Island. The basal member consists mainly of sandstone, coal, and carbonaceous shale. The coal is locally burnt to red cinders. This member is about 25 feet thick. The middle member is formed of grey shale, siltstone, and fine-grained sandstone. It lacks carbonaceous material and appears to be, in part at least, of marine origin. This member varies from 300 to 500 feet in thickness. The upper member comprises mainly sand, shale, seams of coal up to 10 feet thick, and carbonaceous shale. It is about 1,500 feet thick.

The relationship of beds that are here referred to the Eureka Sound Formation, and the Christopher Formation presents unsolved problems. In the Sverdrup Basin (*see* Tozer, 1960) of the Queen Elizabeth Islands two formations, the nonmarine Hassel Formation and the overlying Upper Cretaceous marine shales of the Kanguk Formation, lie stratigraphically and conformably between the Christopher and Eureka Sound Formations. Outside of the Sverdrup Basin, in other parts of the Queen Elizabeth Islands, the Eureka Sound Formation is transgressive and rests directly on various older systems. The absence of the Hassel and Kanguk Formations on Banks Island may be due to a disconformity at the base of the Eureka Sound Formation, although this is not apparent. Alternatively, equivalent beds of the Hassel and Kanguk Formations may be included in beds (lower and middle members, respectively) mapped here as parts of the Eureka Sound Formation. If this is so, then only the upper member of beds assigned to the Eureka Sound Formation on Banks Island is correlative with typical beds of this formation. The age of the Eureka Sound Formation as established in other parts of the Arctic Archipelago is early Tertiary, and possibly includes beds of late Upper Cretaceous age.

5. The youngest sequence is formed by the Beaufort Formation which outcrops in western Banks Island where it rests with transgressive unconformity on older formations. This formation is represented mainly by discontinuous exposures that are generally overlain unconformably by younger Pleistocene and Recent surficial deposits. Continuous and readily mapped exposures of Beaufort beds are limited to the northwest corner of Banks Island and there only, has this formation been mapped separately. The Beaufort beds apparently dip gently toward the west and northwest.

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Table of Formations

Era	Period or epoch	Group, formation, map-unit and approximate thickness (feet)	Lithology
Cenozoic	Pleistocene and Recent		Glacial gravels, morainal debris, silt, clay, lake and stream sediments, marine sediments
	Unconformity		
	Late Tertiary and Quaternary	Beaufort 400	Gravel, sand; minor silt, peat, driftwood (nonmarine)
	Unconformity		
	Early Tertiary	Eureka Sound 2,000 ±	Sand, sandstone, silt, siltstone shale; minor carbonaceous shale, coal, lignitic coal, clay ironstone beds (nonmarine and marine)
	?Disconformity		
Mesozoic	Cretaceous	Christopher 1,000–1,200	Shale; minor sandstone, clay ironstone beds and concretions, septarian nodules (marine)
		Isachsen 0–300	Sandstone, conglomeratic sandstone; minor coal and carbonaceous shale (nonmarine)
Unconformity			
Palæozoic	Devonian	Melville Island 4,000	Sandstone; minor siltstone, shale, reefoid limestone (nonmarine and marine)
		Blue Fiord (thickness not known)	Limestone; minor dolomite, shale (marine)
	Contact not exposed, probably structurally conformable		
	Silurian	Read Bay Group 675 ±	Limestone, dolomite, dolomitic limestone, shale (marine)
	Ordovician and Silurian	Map-unit 10b 3,000	Dolomite; minor chert, sandstone, shale (marine)
	Cambrian(?)	Map-unit 10a 0–400	Sandstone; minor shale, siltstone, dolomite (marine)

	Unconformity		
Later Precambrian		Map-unit 9	Gabbro dykes and sills
		Intrusive contact	
		Natkusiak 1,000	Basalt flows, minor agglomerate
		Disconformity	
	Shaler Group	Kilian 1,600	Gypsum, anhydrite, shale, sandstone, limestone, siltstone, dolomite (?marine)
	Shaler Group	Wynniatt 2,700	Limestone; minor dolomite, shale, sandstone, anhydrite, gypsum (?marine)
	Shaler Group	Minto Inlet 300–1,200	Gypsum, anhydrite, minor sandstone, limestone, shale, gypsiferous shale, dolomite, siltstone (?marine)
	Shaler Group	Reynolds Point 2,300	Limestone, sandstone; minor siltstone shale (?marine)
	Shaler Group	Glenelg 3,500	Sandstone, limestone, shale siltstone, dolomite, conglomerate (?marine)
	Unconformity		
Earlier Precambrian		Map-unit 2	Granodiorite
		Intrusive contact ?	
		Map-unit 1 (thickness not known)	Quartzite; minor micaceous quartzite, hematitic quartzite, greywacke

The Beaufort Formation is composed of gravel, sand, minor silt, and peat. Unaltered logs and fragmented wood are conspicuous constituents in the gravel and sand. The maximum exposed thickness of this formation on Banks Island is about 300 feet. On the basis of microfloras, Beaufort beds are dated as ranging from late Tertiary to early Pleistocene.

Description of Formations

Earlier Precambrian

Map-unit 1

A sequence of mainly quartzitic rocks that outcrop over a limited area on the west side of Hadley Bay in northeastern Victoria Island are considered to represent the oldest formation in the map-area. The regional strike of these rocks is about N20°E; the dip is northwesterly at angles varying from 20 to 70 degrees. The predominant lithologic type is a relatively pure quartzite. Micaceous quartzite, micaceous hematitic quartzite, and greywacke form minor constituents. These rocks are pink and grey, and thin to thick bedded. Bedding, however, is for the most part indistinct and the rocks are partly schistose. Quartz veinlets up to one inch thick and basic dykes cut this formation, but there are apparently no sills. No reliable estimate of the thickness could be made but it seems certain that several hundred feet of beds are present.

Map-unit 2

Granitic rocks outcrop on the west side of Hadley Bay in northeastern Victoria Island where they occupy an area of about 2½ square miles (*see* Pl. V); they

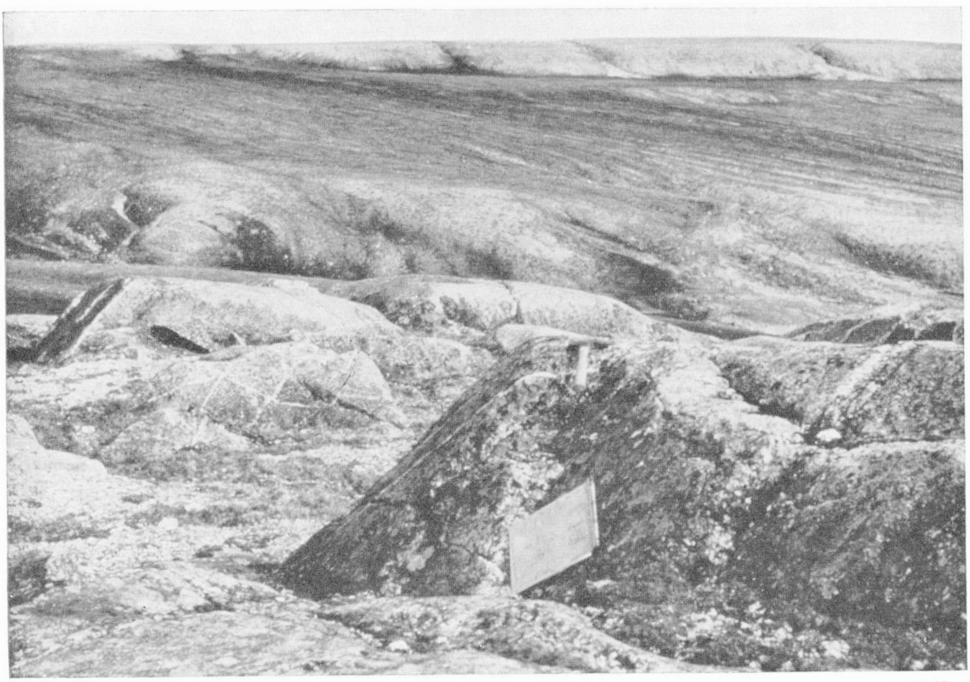

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Plate V. *Precambrian granodiorite outcrops on the west side of Hadley Bay, northeastern Victoria Island. In the background Ordovician and older (?) beds (map-units 10a and 10b) lie nonconformably on the granodiorite.*

are exposed also on a small island in Hadley Bay, about 3 miles from the principal exposures and are presumed to represent parts of the same body. These rocks vary in colour from grey to pink, are fine to coarse grained, and are cut by numerous veinlets of quartz. They are composed essentially of varying amounts of plagioclase, microcline, quartz, biotite, muscovite. The composition appears to be approximately that of a granodiorite.

The granitic rocks lie in contact with the formation of quartzites and schistose rocks (map-unit 1). Although the contact between the two formations is apparently not exposed, it is assumed that the granitic rocks are younger. The massive non-foliated granitic rocks are tentatively interpreted as intrusions emplaced after the folding and metamorphism of the quartzitic rocks of map-unit 1.

Palæozoic rocks (map-unit 10a) rest directly upon the granite. The contact is nonconformable and the granite is therefore unquestionably Precambrian. Furthermore the granitic rocks are overlain by a small isolated exposure of unmetamorphosed conglomerate that probably represents the basal bed of the Glenelg Formation. The granitic rocks thus appear to be younger than map-unit 1, yet older than the Shaler Group; their age has been determined by the potassium-argon method to be 2,405 million years.

Later Precambrian

Shaler Group

A thick sequence of five formations, here named the Shaler Group, overlies unconformably the high-rank metamorphic rocks (map-unit 1). The names of all five formations are new. In ascending order these formations may be briefly characterized as follows: 1, Glenelg Formation, varicoloured clastic and carbonate sediments; 2, Reynolds Point Formation, grey limestone and sandstone; 3, Minto Inlet Formation, gypsum and anhydrite; 4, Wynniatt Formation, grey limestone; and 5, Kilian Formation, varicoloured clastic and carbonate sedimentary rocks, gypsum and anhydrite. The Shaler Group is overlain disconformably by an assemblage of volcanic rocks that are named the Natkusiak Formation (*see* p. 37).

The type sections and best exposures of this group occur in the Shaler Mountains, the rugged belt of country that extends across Victoria Island from Amundsen Gulf to Hadley Bay. From the viewpoint of geological structure, this belt constitutes the Minto Arch. In this area, the beds of the Shaler Group are gently folded, the two principal folds being the Holman Island syncline and the Walker Bay anticline. On the south limb of the Holman Island syncline, at the head of Hadley Bay, the basal beds of the Shaler Group are exposed and successively younger beds appear toward the axis of the syncline. In the Walker Bay anticline, north of Minto Inlet, the oldest exposures represent the Reynolds Point Formation.

The upper four formations of the Shaler Group are known only in the Minto Arch area. Rocks that are correlated with the basal formation (Glenelg) occur beyond the Minto Arch, in widely separated parts of the map-area. These isolated occurrences of the Glenelg occur at: southern Banks Island, on the spectacular sea-cliffs and in smaller exposures inland; on the Richardson Islands, and the neighbouring coast of Victoria Island; and in the country between Wellington Bay and Washburn Lake.

The rocks of the Shaler Group and the overlying Natkusiak Formation are intruded by gabbro sills and dykes. The more prominent dykes have been individually mapped (map-unit 9); the sills are very numerous and are not shown on the map. These sills, together with talus and felsenmeer derived from the sills, probably occupy at least half of the area mapped as the Shaler Group. These sills are described separately and are not discussed with the description of the sedimentary formations. The thicknesses given for the formations of the Shaler Group do not include the thickness of the sills unless otherwise stated.

The rocks of the Shaler Group are not highly altered. The strata adjacent to dykes and sills have suffered some contact metamorphism but remote from the intrusions the sedimentary rocks show remarkably little diagenetic change. Sandstones are commonly weakly consolidated; shales are evenly bedded and devoid of cleavage and the carbonates would not appear out of place in a Palæozoic succession. The presence of sedimentary gypsum and anhydrite is an unusual, and perhaps unique, feature for a Precambrian succession. The facies of the Shaler Group resembles that of shallow-water marine successions of Palæozoic and younger age. Some of the sandstones may have been deposited under nonmarine conditions but most of the group is almost certainly a marine deposit.

Glenelg Formation

The name Glenelg Formation is here proposed for a thick and varied assemblage of sedimentary rocks that rest unconformably upon the early Precambrian rocks exposed at the head of Hadley Bay. The name is chosen from Glenelg Bay, an adjunct of Wynniatt Bay, on the north-central coast of Victoria Island, where the upper part of the formation is well exposed (*see* Pl. VI).

In the Shaler Mountains two members are recognized within the Glenelg Formation. Extensive exposures of both the lower and upper members occur on the south limb of the Holman Island syncline, west of Hadley Bay. These exposures have not been studied in detail. At Glenelg Bay only the upper member is exposed; older beds, if present, are concealed by the overlying Palæozoic cover.

A small outlier of red sandstone and quartz-pebble conglomerate overlies the granite outcrops (map-unit 2) at the head of Hadley Bay. These rocks may represent the basal beds of the Glenelg Formation.

Exposures of the lower member on the west side of Hadley Bay overlie, unconformably, the metasediments of map-unit 1. Precise measurements of these beds have not been made, but the thickness of the lower member in this area is probably in the order of 2,000 feet. The following rocks occur in alternating sequence: red, white and grey sandstone and orthoquartzite, fine to medium grained, and thin to thick bedded; dark grey shale, in units up to 100 feet thick

Plate VI. *Looking east over the Shaler Mountains and the southeastern shore of Glenelg Bay, northern Victoria Island. Formations of the Shaler Group are dipping south, toward the axis of the Holman Island syncline. (RCAF T334R-76)* and characterized by concretions up to a foot in diameter; red and grey, thin-bedded siltstone; and grey dolomite, aphanitic to fine grained and thin to thick bedded. Beds of quartz-pebble conglomerate constitute a minor lithological constituent in the basal part of this member. The beds of the upper member on the west side of Hadley Bay were not examined in detail, but cursory examination suggests that they resemble the upper beds exposed in Glenelg Bay, described in the following paragraph.

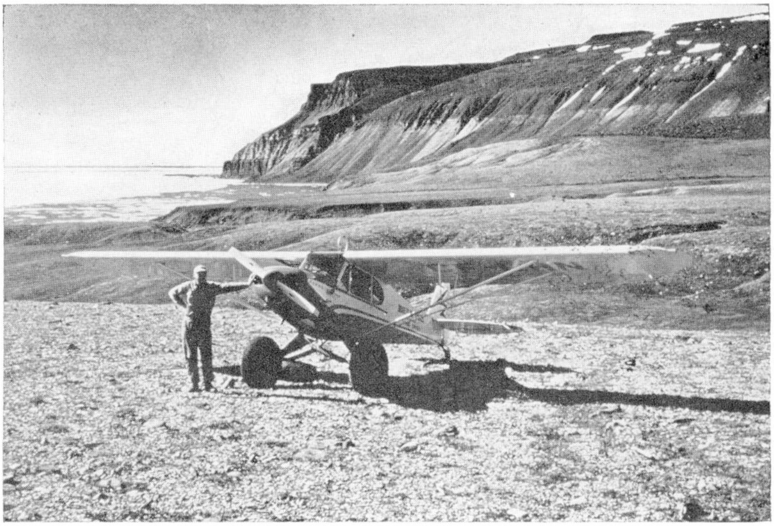
About 1,200 feet of the upper member is exposed at the head of Glenelg Bay, where the beds are followed by the Reynolds Point Formation. The principal rock type of these upper Glenelg beds is quartzose sandstone, light grey to moderate red, fine to medium grained, thin to mainly thick bedded, partly weakly cemented and partly with siliceous cement. In this area the uppermost unit of the Glenelg Formation is fine-grained, thick-bedded, stromatolitic dolomite. This dolomite is commonly moderate reddish orange to reddish brown, or one of these colours mottled with various shades of grey. At the head of Glenelg Bay this stromatolitic dolomite is about 60 feet thick; at Reynolds Point, at the entrance to the Bay, it is about 125 feet thick (*see* Pl. XI). The dolomite weathers to a characteristic light brown and forms a readily recognized horizon within the Shaler Group of northeastern Victoria Island.

Several isolated inliers of Precambrian rock occur in the southern part of the map-area. One relatively large area occurs at the Richardson Islands and on the adjacent coast of Victoria Island. A substantial belt extends from Wellington Bay to Washburn Lake. The rocks exposed in these areas have been only briefly examined. The sedimentary rocks comprise hard, red, coarse-grained quartzose sandstone and quartz-pebble conglomerate. The rocks are horizontal or gently inclined. Gabbroic rock is associated, and some of the smaller inliers expose only gabbro. These beds are tentatively correlated with the Glenelg Formation.

Magnificent exposures of Precambrian rocks occur on the sea-cliffs of southern Banks Island (*see* Pls. VII, VIII, IX). At Nelson Head about 1,400 feet of sedimentary rock and gabbro is exposed (*see* Pl. VII). There the sedimentary rock is mainly sandstone, light red to dusky red, fine to mainly medium grained, thin to thick bedded, and partly micaceous. Minor constituents include interbeds of dark grey shale and siltstone. The varying shades of red of the sandstones and the dark colour of the interlayered gabbro sills impart a striking banded appearance to the cliffs of Nelson Head. At Cape Lambton (*see* Pl. IX), 8 miles west of Nelson Head, a sequence of interbedded grey, thin- to medium-bedded limestone, cherty limestone and chert, about 470 feet thick, is exposed beneath red sandstones similar to those of Nelson Head. This carbonate, a chert sequence, resembles beds within the lower member of the Glenelg Formation of northeastern Victoria Island. The overlying sandstones are like the upper Glenelg beds of Glenelg Bay. Accordingly the Precambrian rocks of Banks Island are tentatively assigned to the Glenelg Formation.

Plate VII

Nelson Head, near southern extremity of Banks Island. The sea-cliffs are about 1,400 feet high and expose Precambrian sandstone and gabbro sills (Glenelg Formation). The view is southeast, toward the north-trending fault-line scarp formed by the Precambrian rocks. In the foreground, beneath the aircraft, are downfaulted beds of the Eureka Sound Formation.



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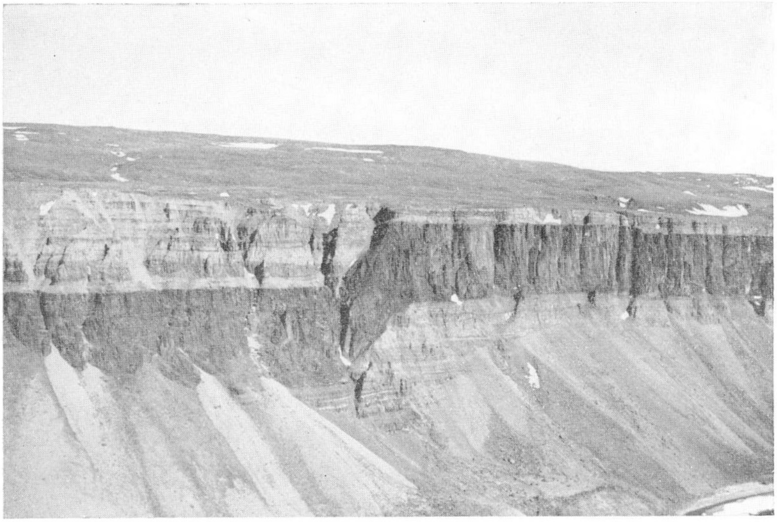

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Plate VIII

Sea-cliffs developed in the Glenelg Formation, between Cape Lambton and the mouth of Atitok River, southwestern Banks Island. The rocks are varicoloured sandstone, cut by a gabbro sill, and overlain by glacial moraine.

Plate IX

Interbedded limestone and cherty limestone, Glenelg Formation, Cape Lambton, southern Banks Island.

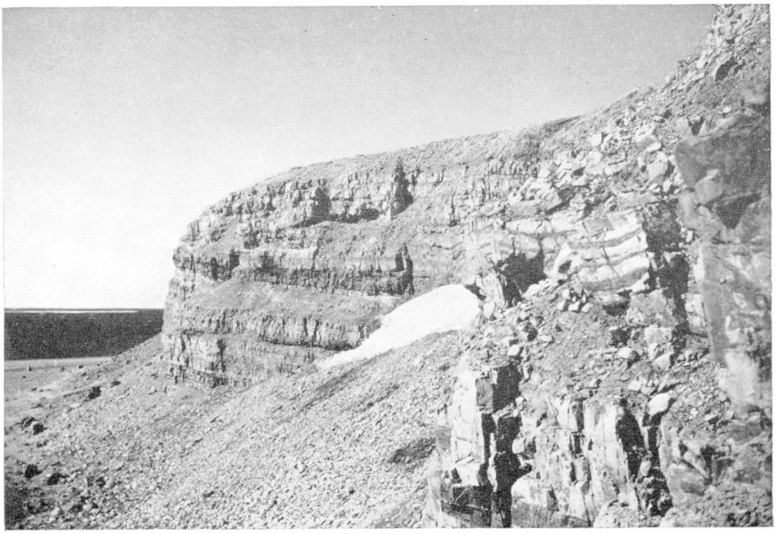

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Plate X. *Looking west over the Shaler Mountains, northern Victoria Island. In the foreground, an extensively exposed sill within the Reynolds Point Formation, represents a stripped structural plane; the northerly trending lineaments are joints. In the background, northwesterly dipping Palæozoic beds (map-unit 10b) are exposed. (RCAF T337R-183)*

Reynolds Point Formation

The Reynolds Point Formation conformably overlies the Glenelg Formation and the contact between the two formations is sharp. The Reynolds Formation consists essentially of limestone and sandstone. Excellent exposures, considered typical, were studied at Reynolds Point, which forms the southeastern entrance to Glenelg Bay on the north coast of Victoria Island. The type section of the Reynolds Point Formation is illustrated in Plate XI.

The typical rocks of the Reynolds Point Formation may be differentiated into three units. The basal, approximately 100 feet, consists of sandstone strata, medium grey, thin to mainly medium bedded, and fine to medium grained; dark grey splintery shale forms a minor constituent. The succeeding 1,900 feet of the formation is composed mainly of a uniform succession of argillaceous limestone and limestone. These rocks are various shades of grey, thin to mainly medium bedded, and aphanitic to fine grained. Interbeds of grey sandstone and shale form a minor constituent as does stromatolitic limestone. The upper 300 feet or so is mainly sandstone, together with calcareous sandstone and minor interbeds of dark grey laminated siltstone and shaly siltstone. The sandstone beds vary from very light grey to dark grey. Less prevalent colours include greenish grey, pinkish grey, and brownish grey. These rocks vary from thin to thick bedded and fine to medium grained. Ripple-marked surfaces are common.

The principal weathering colours of this formation are light grey to medium light grey.

Minto Inlet Formation

The Minto Inlet Formation is here named for a sequence of interbedded anhydrite, gypsum, and thin-bedded varicoloured clastic and carbonate sediments that conformably overlies the Reynolds Point Formation. Typical exposures outcrop around the head of Minto Inlet on the west coast of Victoria Island. The aggregate thickness of this formation as determined from a composite section in the broadly designated type locality is roughly estimated as 1,200 feet. Thinner sections are represented in northeastern regions of Victoria Island. Graphic measurement of Minto Inlet beds south of Glenelg Bay (*see* Pl. VI) indicates a thickness of about 700 feet. Farther to the northeast and on the unnamed peninsula that forms the west entrance to Hadley Bay, the thickness of the formation appears to be less than 300 feet.

More than half of the Minto Inlet Formation is composed of white, mainly thin-bedded gypsum and anhydrite. Less significant colours include moderate orange-pink, greyish green, and greyish purple. The remainder of the formation is composed of the following rock types, arranged in decreasing order of importance (1) sandstone, variably argillaceous and calcareous, greyish red to moderate red, generally fine grained and thin bedded; (2) limestone, greyish green, light to dark grey, aphanitic, commonly thin bedded; (3) shale, calcareous shale and gypsiferous shale, greenish grey, light to dark grey; (4) dolomite, light to dark grey, aphanitic to fine grained, and thin to thick bedded; and (5) siltstone, variable calcareous, greyish red to moderate red and thin bedded.

Plate XI. *Type section of Reynolds Point Formation, near Reynolds Point, at the northeastern entrance to Glenelg Bay, northern Victoria Island. Most of the dark coloured rock capping the cuestas is gabbro, in the form of sills. The X marks the surface of a bed of stromatolitic dolomite, more than 100 feet thick, at the top of the Glenelg Formation. (RCAF A16132-93)*

Wynniatt Formation

The Wynniatt Formation comprises a thick, uniform succession of mainly dark coloured limestone that rests with abrupt contact on the Minto Inlet Formation. Typical rocks of the Wynniatt formation are exposed on the east side of Kilian Lake in northwestern Victoria Island. They were studied on a traverse that was made across the northeasterly striking belt formed by Wynniatt rocks in this region. There the Wynniatt Formation is well-exposed in a series of north-facing escarpments. The formation is named for Wynniatt Bay, a prominent indentation on the north coast of Victoria Island, directly north of the type locality. The thickness of this formation at the type locality is about 2,700 feet and this is considered to represent the probable order of thickness for this formation throughout Victoria Island.

Limestone and argillaceous limestone that are mainly medium dark grey and greyish black, aphanitic, and thin to medium bedded, constitute about 90 per cent of the Wynniatt Formation in the type section. The principal weathering colour is light grey; very light grey, medium light grey, greenish grey and greyish yellow are less significant. These rocks commonly weather to flagstones and blocks that produce a clinking sound under-foot. Stromatolites, generally distinctive in shape and size, characterize several horizons within the formation. Autobrecciated limestone surfaces and desiccation fractures constitute rare sedimentary structures. Oblate to spheroid calcite concretions, up to several inches in diameter, occur at several horizons. The character and mode of occurrence of the concretions are strikingly similar to the graptolite-bearing concretions described by Thorsteinsson (1959a, p. 83) as the Cape Phillips Formation of Ordovician and Silurian age on Cornwallis Island.

The remaining 10 per cent or so of the Wynniatt Formation consists of the following lithic types that are here arranged in decreasing order of importance: dolomite, greyish black calcareous shale, dolomitic sandstone, and gypsum. Varying thicknesses of dolomite are intercalated throughout the formation. As a rule the dolomite is fine grained, medium grey to dark grey, and thin to medium bedded. Like the predominating limestone and argillaceous limestone of the formation, the dolomite generally weathers to lighter shades of grey. However, in the lower part of the formation certain units of dolomite beds weather to a distinctive moderate reddish orange that contrasts the prevailing drab grey.

Kilian Formation

The Kilian Formation overlies the Wynniatt Formation with a sharp, yet conformable contact; its upper contact with the volcanic rocks of the Natkusiak Formation is marked by an erosional unconformity. The name is taken from Kilian Lake, about 8 miles south of Glenelg Bay on the central-north coast of Victoria Island. The formation comprises a heterogeneous assemblage of dominantly thin-bedded, varicoloured sediments, and is about 1,600 feet thick. Two members are distinguished within this formation in the Kilian Lake area:

the lower member is characterized by the presence of gypsum and anhydrite; the upper member lacks evaporites. The typical rocks are best known from two localities. The lower member is well exposed directly south of Kilian Lake. Good exposures of the upper member occur some 10 miles southwest of the southern extremity of Kilian Lake, on the prominent north-facing escarpment formed by the Natkusiak volcanic rocks. At these localities each member is about 800 feet thick. The contact between the members appears to be gradational.

The principal lithologic types in the lower member are: white, light grey, moderate pink and light red gypsum and anhydrite; light grey to medium light grey, and greyish green gypsiferous shale; medium light grey to medium grey, and greenish grey shale and calcareous shale; pale reddish brown and moderate red, fine-grained sandstone, and calcareous sandstone, and siltstone that is similar in colour; and light grey to medium grey, fine-grained to mainly aphanitic dolomite. Crossbedding, ripple-marks, and desiccation fractures occur and attest to shallow-water conditions of deposition. Minor constituents include grey and greenish grey argillaceous limestone and limestone. Gypsum, anhydrite, and gypsiferous shale constitute about two thirds of this member.

The upper member is lithologically similar to the lower member with the exception that gypsum, anhydrite, and gypsiferous shale are absent. The upper member is formed mainly of shale that is variably brownish grey and green; light grey, greenish grey, greyish red, aphanitic argillaceous limestone; light grey to medium grey, fine-grained to mainly aphanitic dolomite; light grey and greenish grey, fine-grained, hard sandstone, and siltstone of similar colours; and softer reddish brown, dusky red and greyish red sandstone.

Stromatolites were not observed in Kilian Lake area but elsewhere these fossils commonly characterize carbonate beds of this formation.

The most prominent weathering colours of the Kilian Formation are light grey, white, and red. They impart a striking appearance to the topography developed on Kilian rocks and contrast the sombre hues of the underlying and overlying formations. The soft nature of several of the lithologic constituents as well as the predominance of thin beds are characters that facilitate erosion. In consequence Kilian rocks generally occupy topographic lows. In other places abundant sills of resistant basic rocks cause the formation to weather in relief.

Only in the Kilian Lake area was a continuous section of this formation studied. It has, therefore, not been possible to determine whether the two described members maintain their identity throughout the extensive belt of outcrops mapped as the Kilian Formation; in fact, as will be noted below, there is some evidence that they may not. Nevertheless, brief observations at several widely scattered localities indicate that, with one exception, the Kilian Formation is everywhere characterized by lithologic types more or less similar to those of the typical rocks. The exception is worthy of note as it suggests the possibility that the upper part of the Kilian Formation that lies west of about longitude 113°20′ may include beds younger than occur in the type area.

Several fine sections of the upper part of the Kilian Formation are exposed south of Minto Inlet, along the escarpment that is formed by the volcanic rocks of the Natkusiak Formation. This escarpment constitutes the southern limits of the valley of Kuujjua River. A section studied briefly near the junction of longitude 115° and the escarpment is shown below.

Section of Kilian Formation on North-facing Escarpment of Kuujjua River

Unit No.		Thickness (feet)
	Overlying strata, volcanic rocks of Natkusiak Formation.	
3.	Sandstone and conglomeratic sandstone; mainly pale yellowish brown to light brown, coarse grained, thick bedded; hard; clasts in conglomeratic sandstone consist of rounded and subrounded granules and pebbles of crystalline quartz; crossbedding is common; thin beds of greyish red, fine-grained sandstone form minor constituent; unit weathers to light grey but is largely covered by black lichens; basal and upper contacts are sharp	385.0
2.	Siltstone and fine-grained sandstone; alternating sequence; greyish red and moderate red, thin bedded; minor interbeds of thin beds of white gypsum and thin beds of grey shale and calcareous shale	155.0
1.	Shale, calcareous shale, argillaceous limestone gypsiferous shale, gypsum, siltstone, and minor fine-grained sandstone; interbedded; thin bedded; principal colours, various shades of grey, white, greyish green and greyish red; contact with overlying unit, gradational	145.0
	Total thickness	685.00
	Underlying strata, covered interval in Kilian Formation.	

The uppermost 385 feet of sandstone and conglomeratic sandstone, described as unit 3, seems to have no counterpart in the type area. It appears to outcrop everywhere around the southwest belt of the Natkusiak Formation that lies south of Kuujjua River (*see* Pl. XII), and to thin in a northeasterly direction. Near the

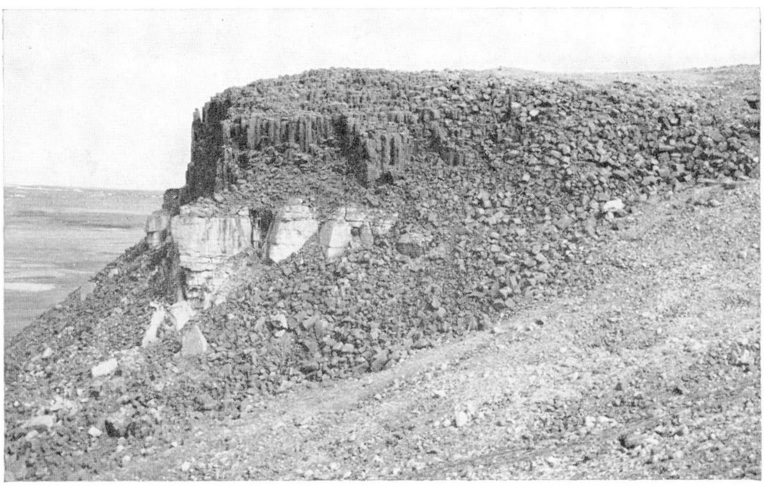

Plate XII

Uppermost thick-bedded sandstone and conglomeratic sandstone unit of the Kilian Formation, south side of Kuujjua River, south of Minto Inlet, Victoria Island. Gabbro sill with columnar jointing overlies the sandstone.

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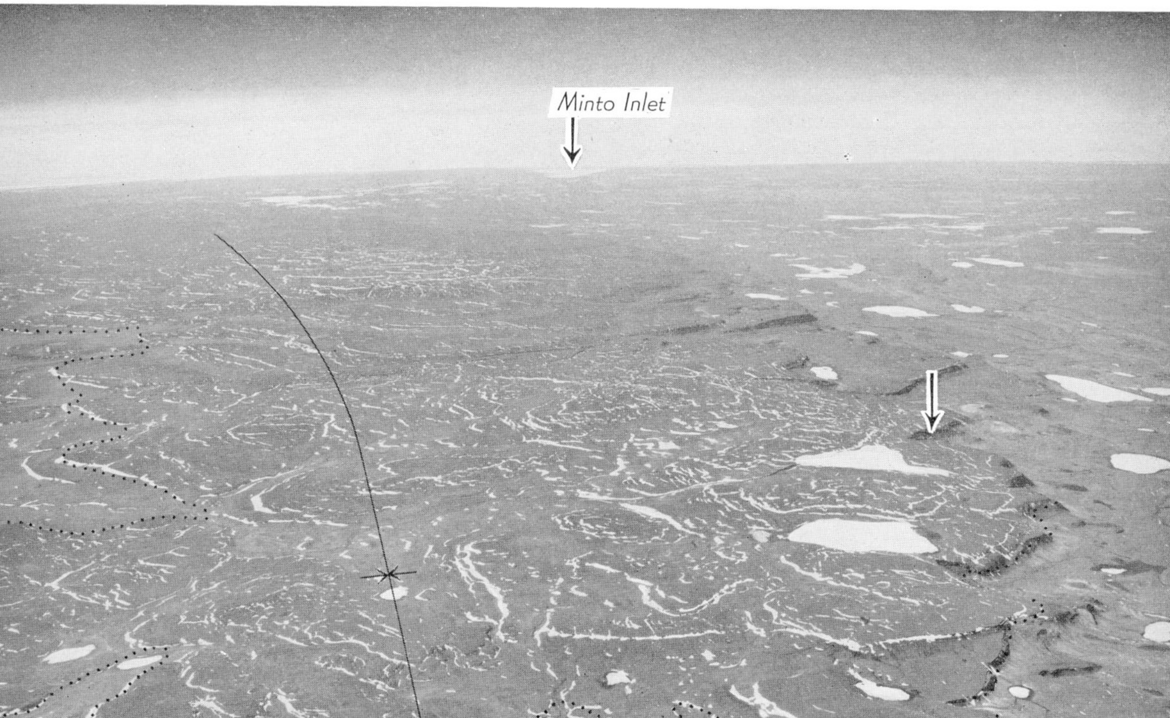

Plate XIII. *View west over the Shaler Mountains, showing the northeastern limit of the Natkusiak volcanic formation. The arrow indicates the position of the type sections of the Kilian and Natkusiak Formations (see also Pl. XIV). (RCAF T334L-66)* southwestern extremity of the northeast belt of the Natkusiak Formation (north of Kuujjua River; about lat. 71°18′, long. 113°40′), this unit is about 100 feet thick. Near the junction of longitude 113°20′ and the northwest-facing escarpment of the Natkusiak Formation the unit is absent and the Natkusiak volcanic rocks rest directly on Kilian rocks that resemble closely the upper member of the Kilian Lake area. Possibly the thick-bedded sandstone and conglomeratic sandstone unit constitutes a third, uppermost member of the Kilian Formation, and perhaps the discontinuous distribution of this unit is governed by the magnitude of the unconformity beneath the Natkusiak volcanic formation.

The presence of evaporites in units 1 and 2 of the described section presents problems that cannot be solved on the basis of available evidence. Possibly these beds (units 1 and 2) are correlative with the upper member of the Kilian Formation in the type area. If this is so, it follows that the two members described in the Kilian Lake area are not distinguishable in the country south and southeast of Minto Inlet. On the other hand, it is also possible that an unconformity underlies the thick-bedded sandstone and conglomeratic sandstone unit which, in certain places, causes thin beds to lie on the lower, evaporite-bearing member of the type area. If this last explanation is correct it would be desirable to separate the sandstone as a distinct formation.

Natkusiak Formation

A sequence of volcanic rocks that consists of dark coloured, presumably basaltic flows and pyroclastic sediments, is here named the Natkusiak Formation. This formation rests disconformably on the Kilian Formation of the Shaler Group and includes the youngest Precambrian layered rocks in the map-area. The Natkusiak Formation is confined to Victoria Island, where it is exposed in two detached belts along the axis of the Holman Island syncline, the principal structural feature of the Shaler Mountains. The formation attains a maximum thickness of about 1,000 feet at about longitude 112°30′. Where individual flows have been recognized they are about 100 feet thick. Amygdules commonly characterize the lower and upper parts of flows, whereas the intermediate rock is dense basalt. Red and green agglomerate, commonly poorly indurated and cut by thin veins of calcite, is locally present at the base of the formation. The agglomerate comprises fragments of volcanic rocks, bombs, and baked sedimentary rocks of various types that are embedded in a matrix of calcite and tuff; it varies from zero to 300 feet in thickness.

The formation is named for Natkusiak, late resident of Holman and well-known travelling companion of Arctic explorer Vilhjalmur Stefansson. Natkusiak's grave is in the Holman cemetery. The type section of the Natkusiak formation is located some 16 miles south of Glenelg Bay in north Victoria Island and is illustrated in Plates XIII and XIV. The basal beds of the type section were examined briefly and measured by barometer; they are described below:

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Plate XIV

Type sections of the Natkusiak volcanic formation (dark coloured), overlying the upper part of the Kilian Formation (light coloured). About 16 miles south of the head of Glenelg Bay (see also Pl. XIII).

Section of Natkusiak Formation in North-central Victoria Island

Unit No.		Thickness (feet)
	Overlying strata, still higher flows in Natkusiak Formation.	
5.	Basalt flow, not examined.	
4.	Basalt flow; as unit 3	100±
3.	Basalt flow; dark greenish grey, very fine grained, amygdules of calcite and chlorite rare in basal 6 inches, abundant in upper 20 feet	90
2.	Basalt flow; lower half dark grey and aphanitic, upper half dark greenish grey and very fine grained, amygdules of calcite in basal 6 inches and of chlorite and calcite in top 20 feet, crude columnar jointing, top surface brecciated	100
1.	Agglomerate; greyish red, comprising angular and subangular fragments and blocks (up to several feet across) of limestone, shale, sandstone, and amygdaloidal basalt embedded in a ground-mass of tuff and calcite; cut by numerous veinlets of calcite; crumbly weathering; irregular bottom contact	80
	Total thickness	370
	Underlying strata, Kilian Formation.	

Gabbro Dykes and Sills

The Shaler Group and the Natkusiak Formation are extensively intruded by diabasic gabbro dykes and sills. The sills vary from very thin units with little lateral extent to units about 100 feet thick that are traceable for tens of miles along strike. The thicker sill and volcanic flows of the Natkusiak Formation dominate the ridged landscape of the Shaler Mountains (*see* Pls. VI, X, XI, XIII). In the vicinity of Holman Post gabbro sills constitute about 90 per cent of exposed rock (*see* Pl. I). The dykes and sills do not intrude Palæozoic rocks.

On freshly broken surfaces the intrusive rocks are characteristically greenish black to black. The principal weathering colour is rusty brown—a character shared with the Natkusiak Formation. Crude columnar jointing characterizes certain sills (*see* Pl. XII). Fine- to medium-grained textures predominate, but locally the rocks are aphanitic to very coarse grained.

Cambrian (?)

Map-unit 10a

This formation consists of an alternating succession of the following rock types, here arranged in decreasing order of importance: sandstone that is mainly green and red, but in part white and pink, fine grained and thin bedded; thin beds of red, green, and grey shale; thin beds of red, green, and grey siltstone; thin beds of fine- to medium-grained glauconitic sandstone; grey, fine-grained, thin-bedded glauconitic dolomite; varicoloured, fine-grained, thin-bedded dolomite. Locally, red, coarse-grained, thick-bedded sandstone and quartz-pebble conglomerate marks the base of the formation. Northwest of the head of Minto Inlet (*see* fossil locality 3) a bed of relatively pure oolitic hematite, about 10 feet thick, lies within this formation. Desiccation fractures, crossbedding, ripple-marks, and salt casts are common sedimentary structures that indicate shallow-water deposition.

This formation includes the oldest Palæozoic rocks in the map-area, and lies with structural unconformity on various Precambrian formations. It is well exposed along the south coast of Victoria Island from about the Richardson Islands to Wellington Bay; Washburn (1947, p. 33) described beds in this belt of exposures from which he collected unidentified brachiopods. In this region map-unit 10a is about 150 feet thick. It is everywhere overlain by the extensively exposed dolomite formation that is referred to in this report as map-unit 10b. The contact between 10a and 10b has been observed at two localities only, and in both instances it appeared to be gradational. Because of the small thickness and erratic distribution of map-unit 10a, as well as the rapidity of field investigations, it was found practical to map this formation separately only on the south coast of Victoria Island. Elsewhere on Victoria Island it is mapped together with map-unit 10b. Map-unit 10a is locally represented along the Palæozoic-Precambrian boundary that extends from about the north entrance of Minto Inlet to Glenelg Bay (i.e., the northern boundary of the Minto Arch). It is also present along the exposed parts of the Palæozoic-Precambrian contact that marks the southeastern boundary of the Minto Arch. It appears to be absent, however, around the small Precambrian inliers that are scattered north of Coronation Gulf in the interior of Victoria Island. As near as could be determined, map-unit 10a is absent around much of the long salient of Precambrian rocks that extend northerly from Wellington Bay. The greatest thicknesses of this map-unit were observed north of the head of Minto Inlet and south of Richard Collinson Inlet, where the formation is about 360 and 400 feet thick, respectively. At neither locality is the base exposed.

There is evidence to indicate that the Precambrian-Palæozoic boundary on Victoria Island is marked by considerable relief. It appears probable, therefore, that map-unit 10a occupies topographic lows on Precambrian surface. Furthermore, it is probable that the source of the sediments of map-unit 10a was the adjacent topographic highs. This explanation alone could account for its erratic distribution.

The following fossils have been collected from map-unit 10a. Identifications are by A. W. Norris of the Geological Survey.

Locality 1. Near north entrance to Minto Inlet, about 6½ miles south of Cape Peter Richards (GSC locality 44291).
linguloid brachiopod
Iphidella? sp.

Locality 2. South coast of Victoria Island, about 10 miles southeast of Cape Colborne (GSC locality 40141).
Lingulella? sp.
linguloid brachiopods

Locality 3. About 12 miles northwest of the head of Minto Inlet (GSC locality 39313).
Dicellomus? sp.

Locality 3A. From beds stratigraphically lower than GSC locality 39313.
Scolithus sp.

Locality 4. About 4 miles northeast of the head of Minto Inlet (GSC locality 39311).
Scolithus sp.

Norris states that none of the fossils from these localities is sufficiently well preserved or diagnostic to date map-unit 10a with any degree of certainty. *Scolithus,* according to Norris, is widespread in early Palæozoic rocks but of little stratigraphic value. The genus identified tentatively as *Iphidella* is fairly common in Middle Cambrian rocks of Western Canada, but also occurs in rocks of Upper Cambrian age. Norris suggests a possible Upper Cambrian age for map-unit 10a, mainly on the occurrence of specimens that may represent *Dicellomus.*

Ordovician and Silurian

Map-unit 10b

Map-unit 10b, composed almost entirely of dolomite, is the most widely exposed formation within the map-area. This formation outcrops throughout roughly three quarters of both Victoria and Stefansson Islands. Throughout this large area the beds are horizontal or gently inclined. The topographic relief is low. As a result, individual outcrops generally reveal a small thickness of beds, representing a mere fraction of the total thickness, and it is difficult to estimate the total thickness of map-unit 10b from outcrop data. On Wollaston

Peninsula exposures are essentially horizontal throughout an area with a relief of about 800 feet. This figure provides a minimum estimate for the total thickness in southwestern Victoria Island. In northwest Victoria Island, south of Richard Collinson Inlet, about 2,000 feet of an incomplete section of map-unit 10b is exposed near a fault. This locality presents the thickest continuously exposed section of map-unit 10b.

Some idea of a maximum limit for the thickness of map-unit 10b may be obtained from aeromagnetic data (*see* Gregory, *et al.,* 1960, p. 10). These data suggest a depth to basement of from 1,000 to 3,000 feet at the east coast of Victoria Island, at latitude 72°N, where the map-unit is exposed at the surface. A similar estimate for depth to basement is given by Gregory (op. cit.) for northern Stefansson Island. There the profile line is close to the boundary between map-unit 10b and the overlying Read Bay Group, which suggests that on northern Stefansson Island the total thickness does not exceed 3,000 feet. According to Gregory the figure could be less than 3,000 feet, because the thickness of rock above the basement, as determined from the aeromagnetic anomalies, could include late Precambrian rocks, if such rocks occur stratified and undeformed beneath the surface of Stefansson Island. Thus the thickness of this formation probably does not exceed 3,000 feet and the maximum thickness in the map-area may approximate this figure. It may be mentioned that this figure is considerably less than the thickness of the contemporary formations on Cornwallis Island. There (*see* Thorsteinsson, 1958, p. 30) the equivalent beds (Cornwallis and Allen Bay Formations) are 10,500 feet thick.

Map-unit 10b is mainly a remarkably uniform and drab succession of dolomite beds that are thin to mainly thick bedded, dense to porous and vuggy, and fine to coarse grained. The dominant colours of this unit are grey, yellow, and brown, weathering grey, yellow, and pink. Other lithologic constituents that form about 2 per cent of the formation include: white, thin beds of porcellanite and grey vitreous chert that commonly occur as breccia; dolomite desiccation breccias; and thin beds of green and grey dolomitic shale and shale; varicoloured fine-grained to aphanitic dolomite, and grey fine-grained sandstone, all of which commonly characterize the basal 50 feet to 150 feet of the formation. On gentle slopes the dolomite beds weather commonly to sugary masses, whereas rough, pitted surfaces generally characterize steep faces. Y. O. Fortier (*see* Fortier, *et al.,* 1953, p. 2087) reports solid bitumen in cavernous dolomite near Greely Haven on the east coast of Victoria Island. This dolomite is considered to belong to map-unit 10b. The presence of reefal deposits on Victoria Island is suggested by vuggy, massive, tabular bodies, up to several feet thick, as well as by other massive beds that are characterized by abundant algal-like structures. Massive hummock-shaped outcrops of dolomite, some up to 50 feet thick, are found on the east coast of Stefansson Island about 40 miles north of Goldsmith Channel, and these may represent bioherms. The basal contact of map-unit 10b with map-unit 10a is described on page 39.

Typical exposures of the dolomite beds of map-unit 10b are illustrated in Plates XV and XVI.

Plate XV

Exposures of Palæozoic dolomite (map-unit 10b), about 4 miles south of Hadley Bay, northeastern Victoria Island.

111955

Fossils are scarce in this map-unit and, as with most fossils that occur in dolomite, preservation is poor. Algal-like structures are perhaps the most abundant fossils. They are of two general types: (1) Hemispherical structures that vary from less than an inch to over 2 feet in diameter. Such structures are composed of successive laminae of dolomite that are variable in texture and colour. Striking features of certain landscapes on Victoria Island are fields of the larger hemispherical mounds that cover stripped bedding planes. (2) Masses of alternating laminae of chert and dolomite that are highly irregular in shapes and sizes, and embedded in a matrix of dolomite. These structures commonly characterize massive beds several feet thick and are suggestive of biostromes.

Poorly preserved invertebrate fossils were taken from widely separated outcrops of map-unit 10b on Victoria Island. The stratigraphic position of these collections, both relative to one another or to the base and top of the formation, could not be determined, but none appeared to occur within the basal few hundred feet of the formation.

The oldest datable collection of fossils was taken on the east coast of Victoria Island, about 10 miles south of Cape Nygaard. Identifications by G. W. Sinclair are as follows (locality 5; GSC locality 40131):

Receptaculites sp.
Gonioceras sp.
cf. *Kochoceras* sp.
cf. *Cyrtorizoceras* sp.

The nautiloid *Gonioceras* is generally considered to constitute an index fossil of the Middle Ordovician, in terms of the North American standard section. Thorsteinsson (*in* Fortier, *et al.*, in press) has recorded *Gonioceras* from the Cornwallis Formation of Ellesmere Island. In the Cornwallis Formation *Gonioceras* seems to characterize a distinct zone, below the zone with the "Arctic Ordovician fauna", which appears in the upper part of the Cornwallis Formation.

Plate XVI. *Boundary between Palæozic and Precambrian rocks on Natkusiak Peninsula, northern Victoria Island. Note also drumlinoid and crag-and-tail hills with northwesterly orientation. (RCAF A16330-57)*

Presumed representatives of the "Arctic Ordovician fauna" have been identified and dated by G. W. Sinclair. These are listed as follows:

Locality 6. South side of Minto Inlet, near entrance to inlet; suggested age—Upper Ordovician (GSC locality 41020).

Streptelasma sp.
Palaeophyllum sp.
Labyrinthes sp.
Maclurites? sp.
Digenuoceras sp.

Locality 7. East coast of Victoria Island, near Isachsen Point; suggested age—Upper Ordovician (GSC locality 40130).

Armenoceras sp.
Apsidoceras sp.

Locality 8. East coast of Victoria Island, near Fredrikshald Bay; suggested age—Upper Middle Ordovician (GSC locality 40132).

Wilsonoceras cf. *W. squawcreekensis* Miller
Nesperorthis sp.
Pholidops cf. *P. trentonensis* Hall
Receptaculites sp.
bryozoans

Poorly preserved representatives of the "Arctic Ordovician fauna", mainly from Read and Sutton Islands, which lie off the south coast of Victoria Island, have been described by Miller and Youngquist (1947). It seems fairly certain that the rocks referred to here as map-unit 10b were the host rock of the fossils described by Miller and Youngquist The stratigraphic relationship of the various collections described by these authors is not known with certainty and some of the fossils were not collected in situ. Nevertheless, Miller and Youngquist conclude that most forms are of Upper Ordovician age. A few of those represented could be as young as Silurian according to these authors, but they state that if the collections represent one fauna only, then it is of Upper Ordovician age.

Graptolites were collected from a 6-inch bed of bituminous shale interbedded with dolomite on Falsen Island, which lies immediately off the east coast of Victoria Island (locality 9; GSC locality 40820). According to Thorsteinsson, one species only is represented and it is identical to *Orthograptus* n.sp. A that characterizes a well-defined faunal zone in basal beds of both the Allen Bay Formation and Cape Phillips Formation (*see* Thorsteinsson, 1959, p. 46). The Allen Bay (Upper Ordovician to Middle Silurian) and Cape Phillips Formations (Upper Ordovician to Upper Silurian) are widely distributed in the Arctic Archipelago and represent shelly and graptolitic facies, respectively. Both formations overlie the Cornwallis Formation. *Orthograptus* n.sp. A is dated by Thorsteinsson (op. cit.) as Upper Ordovician.

The stratigraphic relationship of *Orthograptus* n.sp. A to any of the occurrences of the Arctic Ordovician fossils on Victoria Island is not known. In its occurrence in the Allen Bay and Cape Phillips Formations to the north and northeast of Victoria Island, *Orthograptus* n.sp. A occurs above, below, and associated with faunas of Arctic Ordovician aspect.

Two small collections of fossils from map-unit 10b have been identified and dated as Silurian by T. E. Bolton. They are listed as follows:

Locality 10. East coast of Victoria Island near Greely Haven; collected by Y. O. Fortier, 1947 (GSC locality 17177).
- cup coral indet.
- favositid coral
- pentamerid brachiopod-*Rhipidium* sp. or *Conchidium* sp.

Locality 11. North Victoria Island, about half-way between Richard Collinson Inlet and the head of Glenelg Bay (GSC locality 41021).
- *Romingeria* sp.
- *Hormotoma* sp.
- ?*Raphistomina* sp.

The range in age of map-unit 10b may be reasonably assumed as Middle Ordovician to Middle Silurian. This is based partly on faunal evidence (discussed above) and partly on the stratigraphic position of map-unit 10b below the Read Bay Formation of Middle to Upper Silurian age. Moreover, a correlation seems fairly well secured between map-unit 10b and the Allen Bay Formation as well as much, if not all, of the Cornwallis Formation. There are, however, indirect reasons, which suggest that map-unit 10b may include beds older than Middle Ordovician, which represents the oldest age determination provided by fossils. These reasons are: (1) No fossils were collected in beds known to represent the basal few hundred feet of the formation; (2) The gradational contact relationship of map-unit 10b with map-unit 10a (the latter is tentatively dated as Upper Cambrian) suggests that the lower part of map-unit 10b may also be as old as Lower Ordovician and Upper Cambrian; (3) Rocks of Lower Ordovician age are now known to occur in the eastern Arctic Lowlands, in Foxe Basin (*see* Blackadar, 1958; Thorsteinsson and Tozer, 1960, p. 5), and consequently might be present also in the western Lowlands.

Silurian

Read Bay Group

The Read Bay Formation was named by Thorsteinsson and Fortier (1954; *see also* Thorsteinsson, 1959) for a thick succession of mainly limestone beds of Middle and Upper Silurian age on Cornwallis Island. This formation bears the well-known *Atrypella* fauna. Later investigations have demonstrated the presence of the Read Bay Formation in Devon, Prince of Wales, and Somerset

Islands (*see* Fortier, 1957; Geol. Surv., Canada, Prel. Maps 19-1959, 20-1959). *Atrypella*-bearing beds in north Devon Island and in Ellesmere Island have been referred to the Douro Formation (*see* Geol. Surv., Canada, Prel. Maps 20-1959, 21-1959).

Three structurally conformable formations are well exposed in the north part of Stefansson Island. They are considered to represent equivalents of the Read Bay Formation, which in this area has the attributes of a group. From oldest to youngest these formations are provisionally designated as map-units 11a, 11b and 11c. Three small areas of outcrop in northwestern Victoria Island are considered as also belonging to the Read Bay Group.

Stefansson Island was remote from the base of the Geological Survey party and relatively little time could be devoted to the study of this interesting area. Estimates of thicknesses of the various map-units in the Read Bay Group are probably not very accurate. The formations of this group as developed on Stefansson Island are described below.

Map-unit 11a is about 400 feet thick and consists of limestone and minor dolomite. It lies with perfect conformity upon the dolomite beds of map-unit 10b. Grey limestone and greyish green limestone dominate the lower part of this formation whereas dolomite predominates in the upper part. The best exposures occur in northwestern regions of Stefansson Island. Typical representatives of the *Atrypella* fauna were collected from map-unit 11a on Stefansson Island and have been identified by T. E. Bolton. They are as follows:

Locality 12. Northwest Stefansson Island (GSC localities 40814, 40810).

Solenopora sp.
Trepostome bryozoan fragments
Parafavosites sp.
Favosites sp.
Syringopora sp.
Howellella sp.
Stegerhynchus? sp.
Atrypella scheii (Holtedahl)
Hormotoma? sp.
Encrinurus sp.
Leperditid ostracods

Locality 13. Northwest Stefansson Island (GSC locality 40811).

Clathrodictyon sp.
Favosites sp.
Howellella sp.
Stegerhynchus? sp.
Atrypella scheii (Holtedahl)
Proetus sp.
Leperditid ostracod

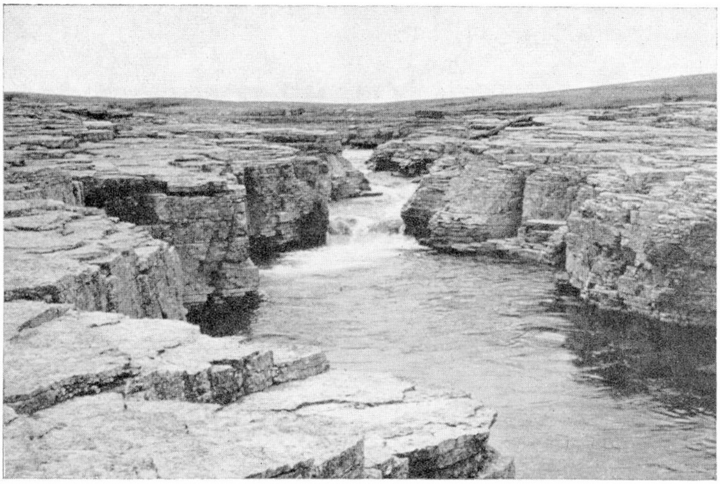

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Plate XVII

Read Bay limestone (map-unit 11a), fossil locality 14, northeastern Stefansson Island.

Plate XVIII

Graptolitic beds (map-unit 11b) of Read Bay Group, fossil locality 16, northeastern Stefansson Island. The strata are dipping gently to the north.

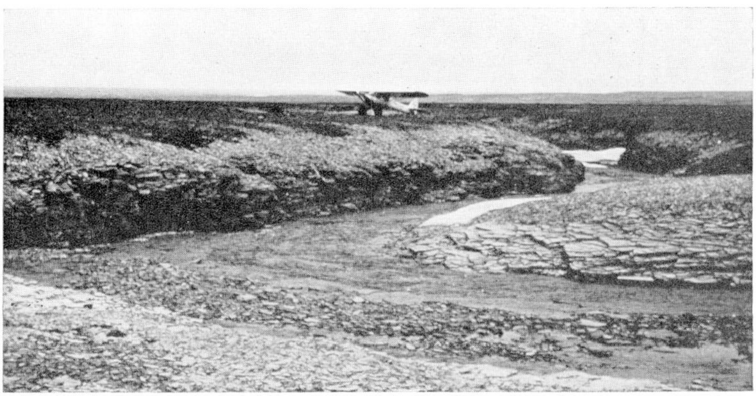

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Plate XIX

Read Bay dolomite (map-unit 11c), north-central Stefansson Island. About 40 feet of beds are exposed at this locality.

Locality 14. Northeast Stefansson Island (GSC locality 40812).
brachiopods—4 or 5 genera
Frammia sp.

Locality 15. North coast of Stefansson Island (GSC locality 40809).
Howellella sp.
Atrypella scheii (Holtedahl)
Megalomus sp.
Hormotoma sp.

Map-unit 11b, the intermediate formation of the Read Bay Group, consists of grey shale that is variably calcareous and weathers grey to greyish yellow. This formation is about 125 feet thick. The only good exposures of this formation are in a small stream in northeastern Stefansson Island, about 5 miles inland from the coast (*see* Pl. XVIII). In this creek *Monograptus* n.sp. and *Monograptus colonus* (Barrande) were collected from shale (locality 16; GSC locality 40818). These graptolites have been indentified by Thorsteinsson, who considers that *M. colonus* indicates a lower Ludlovian (Upper Silurian) age.

Map-unit 11c comprises at least 150 feet of grey, thin-bedded dolomite that is apparently unfossiliferous. The formation is well exposed along several streams that drain the north coastal region of Stefansson Island and it includes the youngest beds exposed on the island.

Typical examples of map-units 11a, 11b and 11c as exposed on Stefansson Island are illustrated in Plates XVII, XVIII and XIX.

Map-units 11a and 11b appear to equate with the lowest member of the Read Bay Formation on Cornwallis Island (i.e., Member A, *see* Thorsteinsson, 1959, p. 70). This correlation is based on the common occurrences of the *Atrypella* fauna in map-unit 11a and in Member A, and the approximate equivalence in age of *Monograptus colonus* (Barrande) in map-unit 11b and *Monograptus bohemicus* (Barrande), a lower Ludlovian graptolite that forms a distinct zone in the upper beds of Member A. Map-unit 11c is admittedly not typical of the Read Bay Formation as developed on Cornwallis Island, but because of the correlation suggested above as well as the absence of evidence to the contrary, map-unit 11c is provisionally correlated with part or all of the three upper members (Members B, C and D) of the Read Bay Formation on Cornwallis Island.

Thorsteinsson (1959, p. 72) has shown that the *Atrypella* fauna in Member A of the Read Bay Formation on Cornwallis Island ranges from Upper Wenlockian (upper Middle Silurian) to Ludlovian (Upper Silurian). It is probable that the Read Bay Group on Stefansson Island spans the same age range.

The total thickness of Read Bay strata on Stefansson Island is about 675 feet.

Exposures of the Read Bay Group on Victoria Island are poor. A collection of fossils taken from a 20-foot section of grey limestone that outcrops near the head of Richard Collinson Inlet on Prince Albert Peninsula have been identified by T. E. Bolton as follows (locality 17; GSC locality 40815): *Solenopora* sp., *Howellella* sp., *Fardenia* sp., *Atrypella scheii* (Holtedahl), *Hormotoma* sp., *Hermannina* sp., and kloedenid ostracods. This exposure probably represents map-unit 11a. Exposures of unfossiliferous dolomite occur west and north of locality 17, and are presumed to equate with map-unit 11c of the Read Bay Group. However, the possibility cannot be excluded that these isolated dolomite exposures may represent the Middle Devonian Blue Fiord Formation, or even map-unit 10b of Ordovician and Silurian age.

In no part of the map-area has the top of the Read Bay Group been observed. Moreover, as the next youngest rocks in the map-area are of Middle Devonian age, the nature of the Siluro-Devonian boundary is unknown. An intensive search was made for exposures of this interval, but without success. The rocks that involve this time are apparently concealed by the thick glacial deposits of Prince Albert Peninsula and by the waters of Viscount Melville Sound north of Stefansson Island.

Devonian

Blue Fiord Formation

Middle Devonian marine sediments, including limestone, dolomite, and shale, are exposed on Prince Albert Peninsula of Victoria Island and are referred to the Blue Fiord Formation (*see* McLaren, 1959, p. 140; Geol. Surv., Canada, Prel. Map 18-1959; ibid., Prel. Map 21-1959). The Blue Fiord Formation is exposed along the southeastern shore of Prince of Wales Strait, from Deans Dundas Bay to within about 16 miles of the northeast end of the strait. Exposures of this formation are also found on the Princess Royal Islands in the middle of Prince of Wales Strait. The lower contact of the Blue Fiord Formation has not been seen; it is presumably concealed by the thick glacial deposits that form the surface of much of Prince Albert Peninsula. The upper contact with the overlying Devonian beds of the Melville Island Formation is apparently concealed by the waters of Prince of Wales Strait.

Fossils are fairly common in Blue Fiord beds. They have been identified by D. J. McLaren, who states that all of the collections are of Middle Devonian age and that most, and perhaps all, are early Middle Devonian (Eifelian). According to McLaren, the fossils suggest a correlation with the Blue Fiord Formation of Ellesmere, Bathurst, and Melville Islands (*see* McLaren, op. cit.; and Thorsteinsson and Tozer, 1959a). One isolated outcrop of dark grey calcareous shale on Prince Albert Peninsula that has been included in the Blue Fiord Formation is lithologically similar to the Eids Formation, which underlies the Blue Fiord Formation on Ellesmere and Bathurst Islands. It cannot be established that the Eids-like outcrop on Victoria Island underlies the principal carbonate exposures included in the Blue Fiord Formation.

Fairly good exposures occur in many of the streams that flow into Prince of Wales Strait. Most of these exposures are isolated, and they generally reveal relatively small thicknesses of beds. Consequently, it has not been possible to construct a stratigraphic section for the whole formation, nor is it possible to suggest the total thickness. As far as known, the thickness of the Blue Fiord Formation is several hundred feet. It is probably considerably less, however, than that of the Blue Fiord Formation of the Queen Elizabeth Islands, where a maximum of 3,800 feet has been measured (*see* McLaren, 1959, p. 740).

Brief descriptions are given below of the rocks and faunas of the Blue Fiord Formation that have been studied on Prince Albert Peninsula and on the larger of the Princess Royal Islands. These descriptions proceed from southwest to northeast.

The exposures at Hay Point, on the north side of Deans Dundas Bay, comprise about 50 feet of grey dolomite with *Amphipora* (locality 18; GSC locality 40797). Mound-like structures in these rocks appear to represent bioherms.

Twelve miles northeast of Hay Point, Blue Fiord beds comprise about 70 feet of dark grey, thin- to medium-bedded, fine- to medium-grained limestone, which weathers light grey (*see* Pl. XX). Fossils collected from these beds include the following (locality 19; GSC locality 40800; ostracods identified by M. J. Copeland, the remainder by D. J. McLaren):

Keriophyllum sp.
Alveolites sp.
Productella sp. C
"*Gypidula pseudogaleata* Hall", of Meyer, 1913
Atrypa 2 spp.
Paracyclas robusta Tolmachoff
rhynchonellid n. gen.?
Molleritia canadensis Copeland
Hermannina cf. *H. consobrina* (Jones)

Isolated outcrops occur 18 miles southwest of Armstrong Point, in the bed of a small stream flowing into Prince of Wales Strait. These beds comprise black shale, calcareous shale, and argillaceous limestone. Fossils collected from this locality (locality 20; GSC locality 40796) have been identified by D. J. McLaren as follows:

Styliolina sp.
Chonetes sp.
Plectospirifer sp.
rhynchonellid indet.

The beds are somewhat disturbed tectonically, and no section was measured. At the southeast end of the outcrop the beds are horizontal. Small folds, and possibly a fault, disturb the beds at the middle of the outcrop. At the northwest limit of the exposure the beds dip gently to the northwest, i.e., they conform to the regional dip. Owing to these structural complications a reliable estimate of thickness could not be made in the time available. The total thickness exposed is probably about 150 feet.

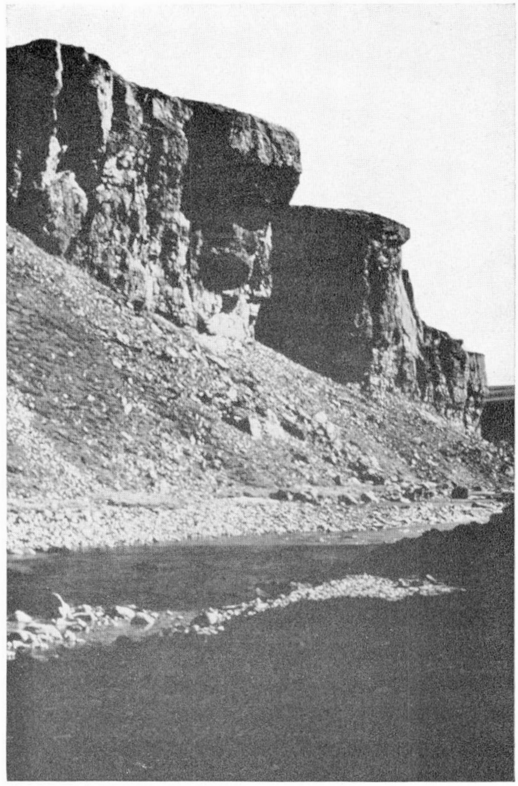

Plate XX

Exposure of Blue Fiord limestone on Prince Albert Peninsula, about 12 miles northeast of Hay Point. (Fossil locality 19.)

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These beds resemble, in lithological and faunal facies, the Eids Formation of Ellesmere and Bathurst Islands (*see* McLaren, *in* Fortier, *et al.*, in press), which underlies the Blue Fiord limestones on those islands. However, the Eids facies is common in Devonian rocks and may occur at more than one level in the Arctic Islands. It is not established, or even suggested, that the Eids-like rocks southwest of Armstrong Point underlie the Blue Fiord limestones of Prince Albert Peninsula. The stratigraphic position of these rocks in relation to the limestones is not known.

Excellent exposures were examined on the larger of the two Princess Royal Islands, in Prince of Wales Strait (*see* Pl. XXI). The occurrence of fossiliferous rocks on these islands was noted in the last century. In 1850-51 HMS *Investigator* wintered near the islands and M'Clure obtained a fossil that was described and figured by Haughton (1857, p. 66, Pl. II, fig. 4). Haughton remarks "at Princess Royal Island . . . this limestone . . . contains a fossil . . . *T.* [*Terebratula*] *aspera,* eminently characteristic of the Eifelian beds of Germany, which form in that country the Upper Silurian strata". The Eifelian beds are now of course assigned to the Devonian, but D. J. McLaren informs the writers that Haughton's correlation is essentially correct.

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Plate XXI

The larger of the Princess Royal Islands, in Prince of Wales Strait. View is to the northeast with the smaller island and the shore of Prince Albert Peninsula in the background. The high, southeast part of the island exposes light grey crinoidal limestone (Blue Fiord Formation of Devonian age). The low-lying northwest part is composed of dark shale and limestone, also assigned to the Blue Fiord Formation.

The high southeastern part of the larger island exposes about 200 feet of light grey, very coarse grained, thick-bedded to massive, bioclastic, in part vuggy, limestone, which weathers to a very light grey, almost white. Much of the rock is composed of large crinoid columnals, up to three quarters of an inch in diameter. Fossils from this limestone (locality 21; GSC locality 40798) have been identified by D. J. McLaren as follows:

Favosites sp. L
dalmanellacid indet.
Gypidula sp. C
rhynchonellid, n. sp.?
Atrypa spp.
Spinatrypa sp. F
"*Reticularia*" ex gr. *R. curvata* (Schlotheim)

According to McLaren, this is an Eifelian fauna like that of the Blue Fiord Formation of Ellesmere and Bathurst Islands.

On the northwest side of the larger island low cliffs expose about 30 feet of grey crinoidal limestone interbedded with dark grey to black shale and calcareous shale. The dark calcareous shales contain many trilobites and other fossils (GSC locality 40794). The strata on the island dip northwesterly and the dark coloured beds are partly stratigraphically above the massive light grey limestone. Viewed from the air, the precipitous cliffs near the southwest tip of the island seem to show interfingering of the light and dark coloured beds (*see* Pl. XXI). Possibly the light coloured massive crinoidal limestone represents talus that accumulated on the margin of a reef and the darker beds to the north may be deposits that accumulated in deeper water adjacent to the reef.

The smaller of the Princess Royal Islands was not visited by the Geological Survey party. Armstrong (1857, p. 268) mentioned that "This little island is rich in fossil remains, chiefly Corallines, *Encrinites* and *Pentacrinites* . . ." This suggests that Blue Fiord limestone is exposed on the smaller island. Some of Armstrong's observations, however, are not likely to be confirmed, for he also records that the "limestone . . . in some situations was plentifully studded with garnets", a barely credible observation because of the unmetamorphosed state of the Devonian rocks of the map-area.

Exposures occur in many of the streams that flow into the northern part of Prince of Wales Strait. Four miles southwest of Armstrong Point a small stream exposes about 12 feet of medium-bedded, fine-grained limestone, in part bioclastic and brown weathering. Fossils collected here include *Atrypa* and *Paracyclas* (locality 23; GSC locality 40799).

At least 100 feet of limestone is exposed in the relatively prominent river that reaches Prince of Wales Strait 16 miles northeast of Armstrong Point (*see* Pl. XXII). The limestone is grey, mainly fine-grained with some fossil debris. It is also characterized by "birdseyes" of crystalline calcite, like those of the Ordovician Lowville limestone of Ontario and New York.

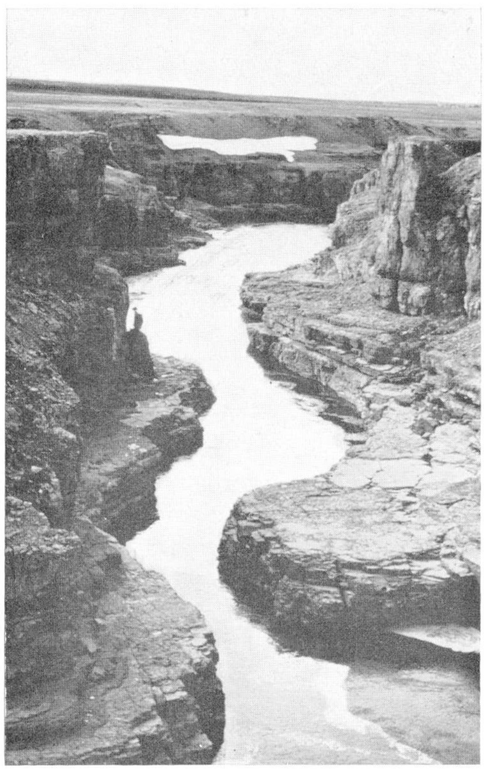

Plate XXII

Canyon on Prince Albert Peninsula, 16 miles northeast of Armstrong Point. Exposures are Blue Fiord limestone. Canyon walls are about 100 feet high.

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The northeasternmost exposures of this map-unit are 16 miles southwest of Peel Point. These beds comprise mainly medium-bedded limestone that is partly argillaceous and characterized by many coquinoid layers and *Alveolites* colonies in position of growth. Partings of green shale also occur in this section, which is about 70 feet thick. Fossils are very abundant and the following have been identified (locality 24; GSC locality 40795):

Alveolites sp. B
Endophyllum sp. A
digonophyllid, cf. *Glossophyllum* sp.
Productella sp. D
Tentaculites sp.
Atrypa spp.
Schizophoria sp.
small "martinioid" brachiopods
"*Schuchertella*" sp.
proetid trilobite fragments

Melville Island Formation

The Melville Island Formation was named by Tozer (1956, p. 14) for a thick sequence of Devonian clastic sediments that outcrop on the west coast of Melville Island. In subsequent investigations of the geology of Melville Island, Thorsteinsson and Tozer (1959a) subdivided and mapped three formations in the rocks that were included previously by Tozer in the Melville Island Formation. The three formations are, as yet, unnamed. In a preliminary report Thorsteinsson and Tozer (op. cit.) refer to these formations as map-units 6, 7 and 8 (from oldest to youngest). The formations are described briefly as follows: Map-unit 6, mainly grey, marine and nonmarine, sandstone, siltstone and shale; 4,500 to 8,000 feet thick. Map-unit 7, mainly white nonmarine sandstone; 2,500 feet thick. Map-unit 8, green, grey, and white, commonly carbonaceous, nonmarine sandstone, shale, and coal; with marine intercalations, 4,000 feet thick.

A thick succession of Devonian rocks represented principally by drab, nonmarine and marine, clastic sediments, occupies a large roughly rectangular-shaped region in northeast Banks Island. Excellent exposures of these rocks, which are here referred to the Melville Island formation, occur in sea-cliffs that face M'Clure Strait (*see* Pls. XXIII-XXV; also figs. 8, 9, 10 and 11 *in* Manning, 1956). As is pointed out later, it is possible that all three of the unnamed formations recognized by Thorsteinsson and Tozer (op. cit.) on Melville Island are represented on Banks Island, however, on the latter island they have not been mapped separately. The regional strike of the Melville Island Formation in northeast Banks Island is about N45°E. The regional dip is northwesterly at angles generally less than 5 degrees. Gently dipping northeasterly trending flexures characterize the northwestern regions of these outcrops but these struc-

Plate XXIII. *Aerial view of northeastern Banks Island, looking west. Note the youthfully dissected plateau developed in the clastic rocks of the Melville Island Formation (Middle and Upper Devonian). The arrows point to a bed of white sandstone that reflects the northwesterly homoclinal dip of the Devonian rocks of northeastern Banks Island. (RCAF T422L-228)* tures have not been precisely delineated. Three small outcrop areas of Melville Island Formation in the heavily drift-covered region on the east coast of Banks Island are clearly related to the structural pattern of the northeast part of the island. The Melville Island Formation is exposed also along the axis of the Cape Crozier anticline near the northern extremity of Banks Island (*see* figs. 41 and 42 *in* Manning, 1956).

The contact of the Melville Island Formation with the underlying Blue Fiord Formation is hidden beneath the waters of Prince of Wales Strait, which in this region appears to follow the strike of bedrock. The Melville Island Formation is overlain unconformably by beds of Lower Cretaceous age.

The Melville Island Formation, as exposed on Banks Island, consists mainly of the following rock types that are here arranged in about decreasing order of importance: grey and greyish green, fine- to medium-grained, thin- to medium-bedded sandstone, micaceous sandstone, and minor calcareous sandstone; grey and greenish grey, thin- to medium-bedded siltstone, micaceous siltstone and calcareous siltstone, grey and greenish grey shale, micaceous shale and calcareous shale; these lithic types weather to drab grey and greenish grey. White sandstone and reefoid limestone constitute relatively minor constituents, together with minor interbeds of grey, fine-grained, red weathering calcareous sandstone, up to 3 feet thick. Carbonaceous fragments, and less commonly fragments of armoured fish characterize beds of sandstone and siltstone. Manning (1956, pp. 43, 44) reports a seam of coal 4 inches thick west of Cape Vesey Hamilton and two seams about 8 inches thick in Pim Ravine. The rocks bearing these coal seams unquestionably belong to the Melville Island Formation. The clastic rocks that dominate the Melville Island Formation are differentially indurated; some beds being virtually unconsolidated and others very hard.

A uniform sequence of white, fine-grained, thin- to medium-bedded sandstone beds, about 100 feet thick, is well exposed in the sea-cliffs that face M'Clure Strait. Plate XXIII shows this white sandstone unit dipping gently northwesterly along the face of the cliffs until it finally disappears below sea-level, about 5 miles southeast of Rodd Head. The white sandstone unit contrasts remarkably with the adjacent and otherwise drab coloured rocks of the Melville Island Formation. On the basis of lithologic similarity, it is suggested that this white sandstone unit on Banks Island may be correlated with map-unit 7 (*see* Thorsteinsson and Tozer, 1959a) on Melville Island. However, as white sandstone sequences of greater thicknesses than the one described above, on Banks Island, were included by Thorsteinsson and Tozer in map-unit 8 on Melville Island, this suggested correlation is perhaps somewhat tenuous.

Magnificent examples of biostromal and biohermal reefs are well exposed in the upper part of the Melville Island Formation on Banks Island (*see* Pls. XXIV, XXV). The reefs, which outcrop over some 50 square miles of country that is centred around a point about 15 miles southeast of Mercy Bay, are more resistant to erosion and lighter in colour than the adjacent grey clastic sediments.

Plate XXIV

View looking north toward Mercy Bay, northern Banks Island. The light coloured knolls are Upper Devonian reefs embedded in typical clastic rocks of the Melville Island Formation. The view is essentially parallel to the strike of bedrock.

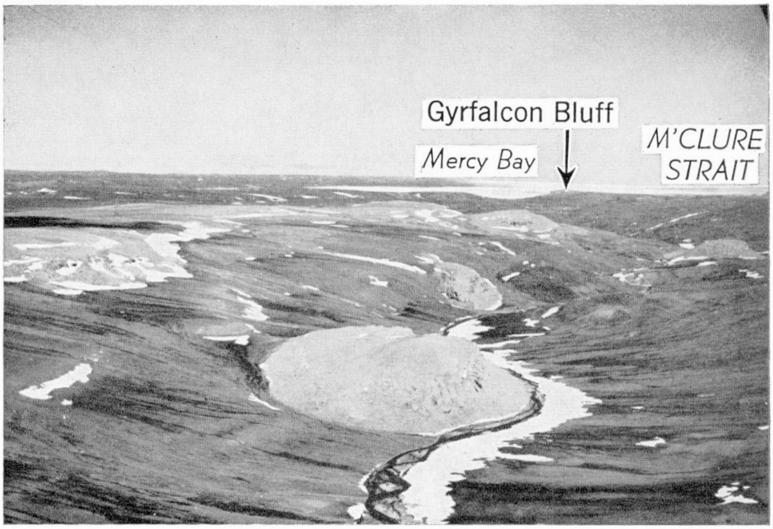

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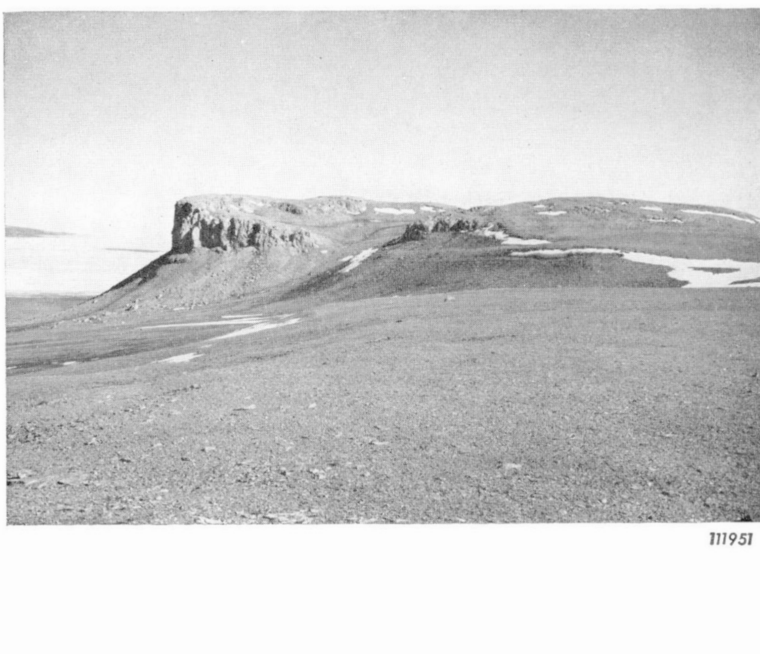
Plate XXV

Gyrfalcon Bluff, near the head of Mercy Bay, northern Banks Island. The bluff is composed of Upper Devonian reef limestone.



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Consequently they stand out as remarkable topographic features on the landscape. About four hours was all the time that was devoted to the study of this interesting area.

The biostromal reefs are formed of tabular masses that pinch out in various directions. Individual biostromes average about 100 to 200 feet in maximum thickness. Three biostromal reefs, separated by 300 to 400 feet of clastic sediments, were observed in sequence on one valley wall about 10 miles southeast of the head of Mercy Bay. The oldest of the reefs at this locality was examined briefly. It consisted of two parts, the upper 100 feet consisting of massive limestone in which the only recognizable fossils consisted of calcareous algae and stromatoporoids; the lower 10 feet or so being formed of interbedded thin beds of bioclastic limestone and soft grey shale. These basal beds are highly fossiliferous and the following forms have been identified (locality 25; GSC locality 40611):

Alveolites sp.
Thamnopora sp.
Phacellophyllum sp. C
Gypidula sp. H

The following brachiopods were collected from sandstone beds about 200 feet stratigraphically below the above fauna (GSC locality 40612).

Nervostrophia sp.
Atrypa sp.
Cyrtospirifer sp.
Eleutherokomma sp.
Cyrtina sp.

Gyrfalcon Bluff is a butte-like feature that rises to an elevation of about 475 feet above sea-level on the east side of the head of Mercy Bay where it forms a striking feature in the landscape (*see* Pl. XXV). About 210 feet of strata are exposed in the upper part of Gyrfalcon Bluff. The lower 70 feet is formed of grey and greenish grey, thin-bedded, generally fine-grained, calcareous sandstone. The uppermost rocks of Gyrfalcon Bluff consist of about 140 feet of limestone believed to represent a biohermal reef. This reef may be divided into two parts. The basal 8 feet consists of thin-bedded, fossiliferous limestone with shale partings that rest with abrupt contact on the underlying sandstone beds. From a collection of fossils made in the limestone beds the following forms have been identified (locality 26; GSC locality 40614):

Alveolites ex gr. *A. suborbicularis* Lamarck
Phacellophyllum sp. C
trepostome bryozoan
Gypidula sp. H
Spinatrypa sp.

The upper part of the reef is formed of uniformly grey, massive, fine- to coarse-grained, slightly porous limestone. Calcareous algae and stromatoporoids were the only fossils observed in this rock. D. J. McLaren, who is responsible for the above fossil identifications remarks as follows:

> Within the area, the fossils of GSC Cat. No. 40614 may be confidently correlated with those of GSC Cat. No. 40611.
>
> The assemblage also suggest close correlation with certain beds in the Upper Devonian sequence on Hay River, N.W.T. The shelly fauna of GSC Cat. No. 40612 contains both *Cyrtospirifer* and *Eleutherokomma*. The range of overlap of these genera is relatively small throughout western and northern Canada. On Hay River they occur together in the lower and middle Hay River shale, throughout a thickness of about 240 feet.
>
> The coral fauna from the reefs of localities 25 and 26 are also similar to middle Hay River shale faunas. *Phacellophyllum* sp. C is widespread in the Hay River region as is *Gypidula* sp. H.
>
> The age of the faunas is considered late lower Frasnian (Lower Upper Devonian). In terms of Alberta rhynchonellid zones they are of *insculpta* to early *albertensis* age.
>
> It is of interest to note that most reefs in the Imperial Formation in the upper MacKenzie River region appear to bear a strong lithological resemblance to the Banks Island reefs, but are later in age, being of middle to late upper Frasnian.

At about latitude 73°28′, longitude 118°21′, the following brachiopods were collected from beds of the Melville Island Formation that are lower stratigraphically than the above described faunas (locality 27; GSC locality 43331):

Eleutherokomma sp. cf. *E. impennis* Crickmay
Spinatrypa n. sp.

The above determinations are by A. W. Norris who states that "The moulds of spiriferids appear to be closely related to *Eleutherokomma impennis* which occurs in the basal part of the Waterways Formation. The coarsely costate *Spinatrypa* n. sp., although different in shape, is analogous in costation to a form in the basal part of the same formation. The Waterways (=Beaverhill Lake) Formation outcrops in northeastern Alberta and is dated as lower Upper Devonian".

Poorly preserved marine fossils, including *Atrypa* and pelecypods, occur in still lower beds of the Melville Island Formation of northeast Banks Island, at latitude 73°14′W, longitude 116°49′W (locality 28; GSC localities 40137, 40138). These fossils have been examined by D. J. McLaren who states that they are too poorly preserved for identification. They may represent the late Middle Devonian (Givetian?) fauna that occurs in lower beds of the Melville Island Formation in the type area and in the Bird Fiord Formation of Ellesmere and Bathurst Islands.

The Devonian rocks of the Cape Crozier region of north Banks were examined briefly. They consist of interbedded sandstone, siltstone, and shale, like the upper beds of the Melville Island Group of Melville and Prince Patrick Islands. No fossils were found, although in view of Armstrong's observations (1857, p. 451) fossils are probably present in these rocks.

Lower Cretaceous

Isachsen Formation

The Isachsen Formation was originally defined by Heywood (1955, p. 28) for about 3,000 feet of mainly nonmarine Lower Cretaceous sandstone beds on Ellef

Ringnes Island. Subsequent geological investigations have demonstrated that this formation is widely distributed throughout the Arctic Archipelago, and is one of the principal stratigraphic units in the Sverdrup Basin. The Sverdrup Basin is centred in about southern Axel Heiberg Island and Amund Ringnes Island and represents an area of profound subsidence and concomitant deposition from Middle Pennsylvanian to early Tertiary. Throughout the Sverdrup Basin the Isachsen Formation varies in thickness from about 300 to 4,500 feet and lies variously on marine sandstone beds of the Mould Bay Formation, or the Deer Bay Formation, a black shale equivalent of Mould Bay beds. The Mould Bay and Deer Bay Formations are of uppermost Jurassic and lowermost Cretaceous age. Isachsen beds are everywhere overlain by marine shale of the Christopher Formation of Albian (Lower Cretaceous) and possibly also Aptian (Lower Cretaceous) age. In southeast Melville Island, south of the southern limits of the Sverdrup Basin, Isachsen beds form a transgressive deposit that rests with angular unconformity on Devonian rocks of the Parry Islands fold belt (*see* Tozer, 1960, p. 4). Outcrops of the Isachsen Formation on Banks Island described here are almost certainly a continuation of the Isachsen beds of southeast Melville Island.

Although greatly variable in thickness, the Isachsen Formation maintains moderately uniform and distinctive characters throughout its area of distribution. A characteristic lithologic type is beds of pebble-conglomeratic sandstone that consists of rounded to subrounded, white quartz pebbles embedded in a matrix of poorly sorted quartzose sandstone.

The only diagnostic fossils taken from the formation are species of *Buchia* that have been dated as Valanginian by J. A. Jeletzky. These fossils were collected from beds near the base of the formation on Ellef Ringnes and Axel Heiberg Islands. Tozer (1960, p. 12), who has recently summarized the stratigraphy, suggests that the greater part of the Isachsen Formation may be of Hauterivian and Barremian age.

Much of Banks Island is underlain by a structurally conformable sequence of Cretaceous to early Tertiary sediments that lies unconformably on Precambrian or Palæozoic rocks; the Isachsen Formation forms the basal unit of this sequence. Outcrops of this formation on Banks Island occur in two regions that are separated from each other by a thickly drift-covered area. Each region is characterized by isolated segments and patches of Isachsen beds.

In north Banks Island, the Isachsen Formation rests unconformably on Devonian rocks of the Melville Island Formation and forms a curved, narrow belt of exposures that can be traced from near Cape Vesey Hamilton on the north coast, southwesterly across the head of Mercy Bay and thence to Thomsen River. From Thomsen River the strike of Isachsen beds turns abruptly to the southeast to where the belt is hidden beneath glacial drift. In this region the formation dips gently away from exposures of the Devonian rocks. Along this belt the Isachsen Formation is about 250 to 300 feet thick. It comprises two units, each of which is weakly consolidated to unconsolidated. The lower unit, approximately 100 feet thick, consists of grey to yellow, fine- to mainly coarse-grained sandstone and grit, and pebble-conglomeratic sandstone. Thin laminae of coal, irregular-shaped clay ironstone concretions up to 3 feet thick, and crossbedding also characterize these beds. Thirty-two miles southeast of Shoran Lake, two coal seams, each about a foot thick, were observed in the basal unit. The upper unit is formed of grey to yellow sandstone that is fine to coarse grained, poorly sorted and generally crossbedded. Limonitic and carbonaceous specks, carbonaceous lenses up to a quarter of an inch thick, and hard bands and concretions of limonitic sandstone occur throughout this unit.

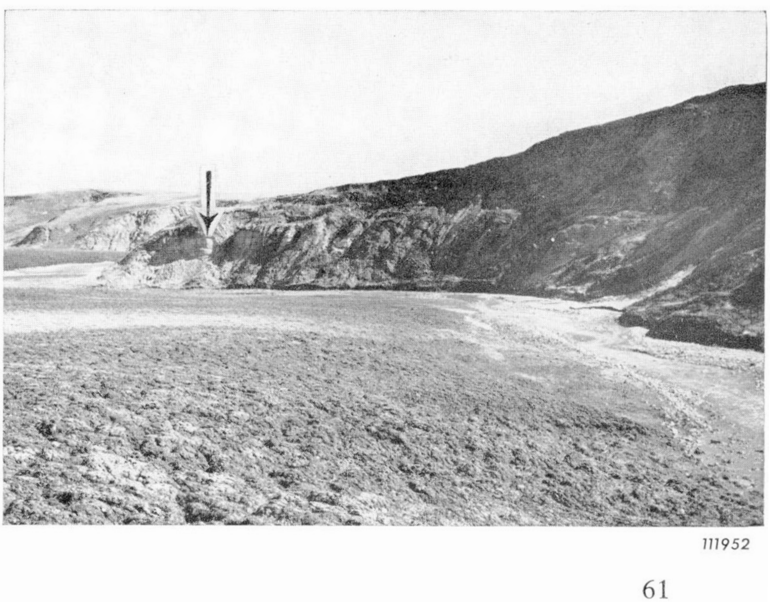
Good exposures of the basal 50 feet of the Isachsen Formation were studied on Able Creek, which enters the west side of Thomsen River, some 25 miles southeast of the head of Mercy Bay. The uppermost 70 feet of the formation is well exposed on Baker Creek, another tributary of Thomsen River, some $6\frac{1}{2}$ miles southeast of the Able Creek section (Pl. XXVI). The lower 250 feet of the Isachsen Formation is well exposed west of Cape Vesey Hamilton where the lower beds are medium-grained to conglomeratic sandstone with laminae of coal. The upper beds consist of mainly fine-grained sandstone with bands of dusky red ironstone.

The Isachsen Formation is apparently absent at the northern extremity of Banks Island in the vicinity of Capes Wrottesley, M'Clure, and Crozier, and Colquhoun Point. In this area the Christopher Formation seems to rest directly upon Devonian rocks, without any intervening representative of the Isachsen.

In southern Banks Island, there are several isolated outcrops of the Isachsen Formation. Where the base is exposed, Isachsen beds can be seen to lie on Precambrian rocks assigned to the Glenelg Formation. Fair exposures of the Isachsen Formation are found along the banks of a small stream about 10 miles north of Cape Lambton, where the interval between the Precambrian and the Christopher Formation accommodates about 200 feet of beds. This figure is presumed to represent the approximate thickness of the Isachsen Formation at this locality. The

Plate XXVI

Upper beds of the Isachsen Formation and the basal beds of the Christopher Formation (Lower Cretaceous). Baker Creek, near junction with Thomsen River, about 28 miles south of Castel Bay, northern Banks Island. The arrow marks the contact between the two formations.



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Isachsen exposures are discontinuous and comprise light grey, soft, carbonaceous sand with marcasite concretions, a 4-inch coal seam and dark grey, carbonaceous shale.

There are poorly exposed outcrops of the Isachsen Formation on the southeast coast of Banks Island, south of Schuyter Point and near Alexander Milne Point. Three miles north of Alexander Milne Point the Isachsen beds comprise about 80 feet of grey sand, and carbonaceous sand with coal fragments. Red ironstone concretions with poorly preserved plant fragments occur in talus. Coal is obtained from exposures near Alexander Milne Point by the natives who live at the Holman Post. The source of this coal is probably the Isachsen Formation, but this was not verified during the present survey.

The Isachsen Formation on Banks Island has not yielded diagnostic fossils. The assignment of these beds to the Isachsen formation is based on (1) their stratigraphic position below beds that are identified unquestionably as the Christopher Formation, and (2) lithologic similarity with the typical Isachsen Formation of the islands that lie to the north of Banks Island.

Christopher Formation

The name Christopher was suggested by Heywood (1955, p. 28) for a lower Cretaceous marine succession consisting of mainly black shale and silty shale on Ellef Ringnes Island. There the Christopher Formation is about 1,540 feet thick. It overlies conformably the Isachsen Formation and it is conformably overlain by nonmarine sandstone beds of the Hassel Formation.

Officers of the Geological Survey who followed Heywood in the Arctic Archipelago have shown that the Christopher Formation is widely distributed, especially within the Sverdrup Basin (*see* Tozer, 1960). Throughout this basin it retains the same stratigraphic position and relatively uniform characters. An aid to the identification of Christopher beds, which are commonly unfossiliferous, are hedgehog concretions composed of radiating calcite crystals. These concretions vary from about an inch to 5 inches in diameter. Round septarian nodules that range from a few inches to 12 feet in diameter also occur.

Throughout most of Banks Island the Christopher Formation lies conformably on Isachsen beds. In the Cape Crozier area, near the northern extremity of Banks Island, it apparently rests directly upon rocks of Devonian age.

In northeastern Banks Island the total thickness of the Christopher Formation is estimated to be about 1,000 feet. Good exposures occur on Thomsen River and some of its tributaries. The Isachsen-Christopher contact is exposed on Baker Creek, near Thomsen River (*see* Pl. XXVI). There the lower 70 feet of Christopher beds comprise an alternating succession of micaceous shale and light grey, fine-grained, sandstone. The cliffs 8 miles west of Cape Vesey Hamilton expose about 200 feet of soft grey micaceous sandstone interbedded with grey shale. Hard, yellow-weathering, calcareous siltstone, with pelecypod fragments, and sandstone nodules cemented by marcasite occur in this section. The beds west of Cape Vesey Hamilton, like those of Baker Creek, occur in the lower part of the Christopher and these sandy beds seem to constitute a distinct lower member of the Christopher Formation which may be recognizable throughout Banks Island. Higher beds of the Christopher Formation are mainly soft, dark grey shale with hard beds and concretions composed of calcareous mudstone and clay ironstone. 'Hedgehog' concretions also occur. These upper Christopher beds are about 800 feet thick and are well exposed on Able Creek and on Thomsen River, at fossil localities 29 and 30.

Exposures of the Christopher Formation occur throughout a fairly extensive area south of Colquhoun Point and Cape Crozier. They also form a small fault-bounded outcrop between Capes M'Clure and Crozier and there is another small outcrop area near Antler Cove. These beds have not been examined in detail but they seem to resemble the Christopher exposures of Thomsen River. Fossils were collected between Capes M'Clure and Crozier, and also at Antler Cove, by T. H. Manning and A. H. Macpherson, in 1952. These fossils have been identified and discussed by J. A. Jeletzky (*see* Manning, 1956, pp. 63-64). The base of the Christopher Formation has not been seen in this area. Immediately east of both Colquhoun Point and Cape Wrottesley, Christopher beds outcrop within 50 feet, stratigraphically, of Devonian rocks without any trace of the Isachsen Formation. It is therefore probable that the Christopher Formation rests directly upon the Devonian in this area.

The Christopher Formation is well exposed in the valleys of the Masik and Atitok Rivers of south Banks Island. The total thickness of the Christopher Formation in this area is probably about 1,200 feet. There, as in northern Banks Island, the Christopher Formation may be divided into two parts. The lower part, about 200 feet thick, consists of interbedded fine-grained sand, sandstone, and shale. These beds are well exposed on Atitok River. The sand is essentially quartzose and irregularly indurated. Some of the sandstone beds are grey, variably calcareous and micaceous, and yellow weathering; others are brown or red and cemented by ferruginous material. Spheroidal masses of marcasitic sandstone also characterize these beds. The shale is commonly grey or brown. Pelecypod shells are scattered throughout the shale and sandstone. They indicate that the lower part of the Christopher Formation, unlike the underlying Isachsen Formation, is of marine origin. The upper part of the Christopher comprises about 1,000 feet of mainly grey shale, with beds and concretionary masses of calcareous mudstone and clay ironstone that weather red and yellow. The best exposures of these upper beds are to be found on the lower reaches of Masik River (*see* fig. 26 *in* Manning, 1956), and south of Raddi Lake.

The basal Christopher beds, and the contact with the underlying Isachsen, is exposed in a small creek 10 miles north of Cape Lambton. There the basal Christopher beds comprise 100 feet of interbedded brown and grey shale and sand. Red clay ironstone and marcasite concretions occur in these beds and in the upper 15 feet there are numerous white pelecypod shells. The underlying Isachsen strata are described above.

Some interesting Lower Cretaceous rocks are exposed in the small graben between Cape Lambton and Nelson Head. At this locality the basal burnt shale of the Eureka Sound Formation is stratigraphically 510 feet above Precambrian sandstone. The interval between the burnt shale and the Precambrian includes 400 feet of beds, followed by a covered interval of 110 feet. The basal 70 feet, resting on the Precambrian, is quartz sandstone with carbonaceous material. The overlying 330 feet include carbonaceous shale, sandy shale, clay ironstone concretions, marcasitic concretions, and a bed of carbonaceous shale. The basal 70 feet clearly represents typical beds of the Isachsen Formation. The overlying beds seem to express a transition between the Isachsen and the Christopher. Probably the covered interval, beneath the burnt shale, represents the Christopher Formation. Although Christopher exposures are poor in this area, the thin stratigraphic interval between the burnt shale and the Precambrian shows that the Lower Cretaceous rocks of the Nelson Head area are much thinner than in Atitok and Masik Valleys, some 25 miles to the north. This section is of considerable structural interest because it suggests that the Nelson Head area may have been tectonically positive in Mesozoic time (*see* p. 73).

One small outcrop of yellow calcareous mudstone with poorly preserved pelecypod shells occurs about 6 miles south of Alexander Milne Point in southeast Banks Island. This isolated outcrop has been mapped as the Christopher Formation, and suggests that the Christopher Formation may be quite extensive in southeast Banks Island, beneath the thick cover of Pleistocene deposits.

The following fossils were collected from the Christopher beds of Banks Island. Identifications are by J. A. Jeletzky.

Locality 29. East bank of Thomsen River, about 8 miles north of junction of Thomsen and Muskox Rivers (GSC locality 40602).

Gastroplites cf. *G. canadensis* (Whiteaves)
Gastroplites sp. nov. aff. *G. liardense* (Whiteaves)
Cleoniceras? sp. indet.
Inoceramus cf. *I. cadottensis McLearn*

Locality 30. Near Thomsen River, about 40 miles south of Castel Bay (GSC locality 40605).

Beudanticeras cf. *B. affine* (Whiteaves)
Cleoniceras (s. 1.) sp. indet.
Lemuroceras? sp. indet.

Locality 30. From beds about 100 feet below GSC locality 40605 (GSC locality 40603).

Beudanticeras affine (Whiteaves)
Lemuroceras? sp. indet.

Locality 31. North bank of Masik River, southern Banks Island (GSC locality 39991).

Beudanticeras affine (Whiteaves)
Lemuroceras cf. *L. belli* McLearn

Locality 32. Near Cape Wrottesley, northern Banks Island (GSC locality 40816).

Arctica limpidiana McLearn
Nucula cf. *N. athabaskensis* McLearn
Psilomya cf. *P. elongatissima* McLearn
Onestia? sp.

Fossils from localities 29, 30 and 31, with ammonoids, are from the upper, shaly part of the Christopher Formation. The collection from near Cape Wrottesley was obtained from beds near the base. The pelecypods obtained by T. H. Manning and A. H. Macpherson, from Antler Cove and from the bay between Cape M'Clure and Cape Crozier are probably also from the lower part of the Christopher Formation (*see* Manning, 1956, p. 63).

J. A. Jeletzky states that two faunal zones are represented in the collection from Banks Island. The collections with *Beudanticeras,* from localities 30 and 31, represent the *Beudanticeras affine* or *Lemuroceras* zone, of late lower, and early Middle Albian age. The collection with *Gastroplites* from locality 29 is dated as latest Middle Albian by Jeletzky. Both these zones are widely represented in the Western Interior region of Canada. The pelecypods from Cape Wrottesley are, according to Jeletzky, closely allied to pelecypods of the *Beudanticeras affine* zone. This pelecypod fauna is well developed in the Clearwater Formation of the lower Athabasca River.

Upper Cretaceous and Tertiary

Eureka Sound Formation

The Christopher Formation of Banks Island is overlain by a substantial thickness (probably about 2,000 feet) of beds, composed of sand, sandstone, silt, siltstone, shale, coal, lignitic coal, carbonaceous shale, and clay ironstone. Most, and perhaps all of this sequence seems to be of nonmarine deposition. These beds are tentatively assigned to the Eureka Sound Formation (*see* Troelsen, 1950; Thorsteinsson and Tozer, 1957; Tozer, 1960, p. 13).

Within the Sverdrup Basin of the Queen Elizabeth Islands the Eureka Sound Formation rests on the marine Kanguk Formation, with marine invertebrates of Upper Cretaceous age. On the east side of the Sverdrup Basin the Eureka Sound beds are transgressive, and overlie pre-Cretaceous formations (*see* Thorsteinsson and Tozer, 1957, p. 25). No Upper Cretaceous marine invertebrates have been found on Banks Island, but it is possible that the lower Eureka Sound beds of Banks Island include marine Upper Cretaceous strata, as noted below.

Three distinct lithological members may be distinguished within the Eureka Sound beds of Banks Island. The lower member is about 25 feet thick and consists of sandstone, carbonaceous shale, and coal. Locally, natural combustion has changed the coal to red shale and cinders. The middle member comprises about 400 feet of light grey shale and fine-grained sandstone, without carbonaceous material. The upper member consists mainly of sand, with minor shale, many seams of coal and carbonaceous shale, and nodules of dusky red ironstone, and is probably about 1,500 feet thick.

The lower member is apparently composed essentially of light grey, fine-grained, soft sandstone, coal, and carbonaceous shale. This basal carbonaceous shale zone, commonly burnt to form brick-red shale and cindery material, is a widespread marker horizon at the base of the Eureka Sound Formation. Good exposures that reveal this relationship occur 10 miles north of Shoran Lake on the banks of Able Creek, which flows from Shoran Lake to Thomsen River. There about 20 feet of carbonaceous shale and coal is exposed. The carbonaceous rock is grey to black and is thinly fissile. In places it weathers light grey to white. In this stream the coal passes laterally into rubbly outcrops composed of hard, thinly fissile, brick-red shale and masses of cinder. A short distance downstream from the exposures of the carbonaceous shale there are outcrops of the Christopher Formation. The contact is not actually exposed but it would appear that the total thickness of the basal member is about 25 feet, and that the boundary between the Christopher and Eureka Sound Formations is abrupt. This basal, locally burnt, shale is present throughout much of Banks Island. Several occurrences have been seen along the belt of basal Eureka Sound beds that extends from near Shoran Lake, across Thomsen River to Mercy Bay. The member is also exposed on the upper Thomsen River, 25 miles southeast of Shoran Lake. Many scattered exposures occur on the north side of Masik Pass and there are also exposures on the upper part of Rufus River, near Durham Heights; the red shale is also exposed in the small graben between Nelson Head and Cape Lambton.

It is tempting to suggest that this basal member, characterized by burnt shale, may be related to the formation that is exposed in the 'Smoking Mountains' on the southwest shore of Franklin Bay. The 'Smoking Mountains' were first discovered by Sir John Richardson, in 1826 (*see* MacKay, 1958, pp. 21-23 for a recent description), about 125 miles southwest of the southernmost exposures of burnt shale on Banks Island. The burnt shale unit extends along a 200-mile belt on Banks Island, at a restricted stratigraphic level. Consequently, it seems reasonable to suggest a correlation of this peculiar rock unit between the localities north and south of Amundsen Gulf. It should be mentioned, however, that there is no evidence that the coal and shale on Banks Island is burning at present.

The middle member of the Eureka Sound Formation of Banks Island consists mainly of light grey shale, sand, silty sand, silt, siltstone, and sandstone. Bedding planes in this member are characteristically stained and encrusted with a yellow mineral, identified as jarosite (*see* Manning, 1953, p. 55). This member is best exposed between Mercy and Castel Bays and in the country west of Thomsen River, north of the mouth of Muskox River. Fair exposures also occur 6 miles from the mouth of the river that flows into M'Clure Strait, 12 miles west of Cape M'Clure. The exposures at Duck Hawk Bluff (*see* fig. 46 *in* Manning, 1956) east of Cape Kellett, appear to also represent this member. The exposures 5 miles west of the head of Mercy Bay comprise about 250 feet of light grey, very soft, thinly fissile, shale with yellow material on the bedding planes and encrusting the outcrops. Clay ironstone nodules occur sparingly; some are dusky red and others have an almost metallic lustre. Soft grey sand and sandstone is interbedded with the shales in the lower part of the sequence. The shales in this member are not carbonaceous and they may be of marine origin. Possibly they are Upper Cretaceous, and are older than the typical Eureka Sound beds of Ellesmere Island. The total thickness of the middle member is not known. It is at least 300 feet and probably does not exceed 500 feet.

D. C. McGregor has identified the following microfossils from carbonaceous shale taken from the middle member of the Eureka Sound Formation about 10 miles northeast of Raddi Lake in south Banks Island (locality 31; GSC locality 5476):

Plankton:

Chlamydophorella sp.
cf. *Cyclonocephalum distinctum* Deflandre and Cookson
Cymatiosphaera spp.
Deflandrea acuminata Cookson and Eisenack
D. sp. cf. *D. micracantha* Cookson and Eisenack
D. sp. cf. *D. tripartita* Cookson and Eisenack
Deflandrea spp.
Epiplosphaera sp.
Hystrichosphaeridium complex (White) Deflandre
cf. *H. xanthopysides* var. *granulosum* Deflandre
H. polytrichum Valensi
H. sp. cf. *H. inodes* Klumpp
Odontochitina sp.
Pterospermopsis sp. cf. *P. eurypteris* Cookson and Eisenack and *P. australiensis* Deflandre and Cookson
Tasmanites sp.

Spores and pollen:

Alisoporites sp.
cf. *Gleichenia*
Pinuspollenites sp.

For this microfauna McGregor suggests a marine environment and a Cretaceous age.

The upper member of the Eureka Sound Formation includes the greater part of the exposures on Banks Island. This member consists of sand, shale, silt, seams of coal and carbonaceous shale, clay ironstone, and minor ferruginous sandstone. The coal beds between Antler Cove and Castel Bay described by Manning (1956, p. 46) represent this member. Grey, medium-grained sand is the dominant rock. Locally the sand is cemented by ferruginous material. Grey silty shale and shale is interbedded as a minor constituent. The seams of coal and carbonaceous shale are at least 10 feet thick. The carbonaceous beds are commonly very fissile

Plate XXVII. *Northern Banks Island, looking east toward Castel and Mercy Bays. The light coloured area in the foreground comprises badlands developed on the upper member of the Eureka Sound Formation. (RCAF T484L-9)* and contain abundant plant stems and wide fronds. In a 350-foot section, 22 miles southwest of Cape M'Clure there are four seams, from 5 to 10 feet thick. One of the most distinctive features of this member is the occurrence of abundant logs of weakly carbonized fossil wood, which occurs in pieces up to 2 feet in diameter and at least 10 feet long. It is distinctly carbonized compared with the wood in the overlying Beaufort Formation. Exposures of this member are extensive throughout north-central Banks Island, north of the latitude of Bernard River. In this area the upper Eureka Sound beds commonly form impressive badlands (*see* Pl. XXVII). Small exposures occur on Bernard River, Storkerson River, at Worth Point, near Stewart Point, west of Jesse Bay, and on Kellett River. These scattered outcrops suggest that this formation underlies most of central Banks Island. The total exposed thickness of this member is probably about 1,500 feet. The upper member is overlain unconformably by the Beaufort Formation. As already mentioned (see p. 21), it is possible that only the upper member is correlative with the typical Eureka Sound beds of Ellesmere Island.

Late Tertiary and Quaternary

Beaufort Formation

The type section of the Beaufort Formation is on Prince Patrick Island. There the formation was defined by Tozer (1956, p. 25) to accommodate about 250 feet of unconsolidated sand and gravel that form the surface of about three quarters of the island. The Beaufort Formation is now known to form a belt of sediments fringing the northwestern islands of the Arctic Archipelago. Besides Prince Patrick Island, regions of the Arctic Islands now known to be underlain by the Beaufort Formation include: all of Meighen Island (*see* Thorsteinsson, 1961); Isachsen Peninsula of Ellef Ringnes Island (D. St. Onge, oral communication); north Borden Island and northwest Brock Island (*see* Thorsteinsson and Tozer, 1959a); and western Banks Island. Throughout these islands the Beaufort Formation rests with marked unconformity on rocks that vary in age from Devonian to early Tertiary. Where determinable, the regional dip is west or northwesterly at low angles. With the exception of glacial and recent surficial deposits, Beaufort beds constitute the youngest known formation in the Arctic Archipelago. The principal outcrop areas of the Beaufort Formation are characterized by distinctive physiographic features. They form monotonous plains that slope gently into the Arctic Ocean, and on which lightly inscribed master streams exhibit remarkably straight and parallel patterns. On the other hand, tributary streams generally present finely textured dendritic drainage patterns. Vegetation is sparse to absent with the result that the plains developed on the Beaufort Formation are generally of barren aspect and reflect the drab grey or greyish yellow colour of weathered sediments.

The Beaufort Formation outcrops over widely scattered regions of Banks Island and lies unconformably on beds of Lower Cretaceous to early Tertiary age. Only in the northwestern part of Banks Island is this formation sufficiently continuous and unmasked by glacial deposits to be mapped separately from the available data (*see* Pl. IV). There the characteristic physiographic expression of the Beaufort is clearly displayed. Within the large central area of Banks Island (the area shown as underlain by map-unit 19) the Beaufort Formation forms a discontinuous cover. Scattered exposures of the Eureka Sound Formation project through this Beaufort cover and various glacial and other surficial deposits overlie the Beaufort. In those northern and southern regions of Banks Island that are shown on the accompanying map as underlain by the Christopher and Eureka Sound Formations many hills are capped by gravels and sands that very probably represent outliers of a once continuous cover of Beaufort beds. These outliers are too small and numerous to be shown on the map. There also, glacial deposits lie on top of the gravel and sand. Except where exposures are fresh, it is difficult to differentiate the Beaufort from younger unconsolidated beds.

On Banks Island the Beaufort Formation is composed of grey, fluvial sand, gravel, minor silt, and peat. The gravel is thin to thick bedded and consists of well-rounded pebbles of chert, quartzite, granite, diabase, dolomite, sandstone, etc. Chert and quartzite are the dominant constituents in the western and northern parts of the island. These resistant pebbles are less abundant constituents of the Beaufort gravels in the southern part of the island. Throughout Banks Island these resistant pebbles are more abundant in the Beaufort than in the younger Pleistocene deposits.

Clasts of cobble size are present but not common. The beds of sand are fine to coarse grained, thin to thick bedded. They are generally well sorted and cross-bedding is common. In addition to quartz the sands contain appreciable amounts of feldspar and various dark coloured minerals. Logs and fragmented wood in a completely unaltered state form a common constituent in the sand and gravel beds and this wood is the most characteristic constituent of the Beaufort Formation. In northwest Banks Island the formation attains a thickness of 400 feet or more.

Preliminary studies by J. Terasmae (*see* Craig and Fyles, 1960, p. 3) have indicated the presence of two microfloras in the Beaufort Formation. A lower assemblage of pollen from Banks, Borden, and Ellef Ringnes Islands suggests a late Tertiary age, whereas an upper assemblage collected on Banks Island is similar to much sparser floras from the overlying Pleistocene (? interglacial) deposits. Craig and Fyles postulate that deposition of Beaufort deposits commenced in late Tertiary times and continued into the early part of the Pleistocene.

Chapter IV

STRUCTURAL GEOLOGY

The rocks of Banks, Victoria, and Stefansson Islands embrace parts of four major structural provinces of the Arctic Archipelago: the Canadian Shield; the Arctic Lowlands, which include relatively undeformed Palæozoic and Mesozoic rocks; the Prince Patrick uplift, a region of Devonian inliers that are characterized by Tertiary normal faulting; and the Arctic Coastal Plain which includes the late Tertiary to early Pleistocene Beaufort Formation. As is shown in the following discussion of these structural provinces, within the map-area the Precambrian Shield and Arctic Lowlands may be further subdivided into regions characterized by distinctive structural features.

Canadian Shield

Earlier Precambrian

Hadley Bay metamorphic region. The oldest rocks in the map-area are exposed over a relatively small area on the west side of the head of Hadley Bay. The rocks involved are mainly quartzite (map-unit 1). The regional strike of this formation is about N20°E and the regional dip is northwesterly at angles varying from 20 to 40 degrees. An angular unconformity separates map-unit 1 from the later Precambrian Shaler Group.

Hadley Bay granitic region. A stock of granodiorite is exposed on the west side of the head of Hadley Bay, and on a nearby unnamed, small island. The granite diorite is presumed to intrude map-unit 1.

Later Precambrian

Later Precambrian sediments are exposed in three general regions of the map-area, namely, northwest Victoria Island where volcanic rocks are included in the sediments, south Victoria Island, and south Banks Island. The later Precambrian rocks of all three regions are intruded extensively by gabbro sills and dykes, and, except for the local effect of thermal metamorphism in the vicinity of the sills and dykes, are quite unaltered.

Northwest Victoria Island. The most conspicuous outcrops of later Precambrian rock form a belt that extends northeasterly across Victoria Island from Minto Inlet and Prince Albert Sound to Hadley Bay. This is the Minto Arch as defined by Fortier, *et al.* (1954), and like the Boothia Arch has been tectonically active within Palæozoic time. Included in the region defined as the Minto Arch are the two small outcrop areas of map-unit 1 and map-unit 2. The dominant structures shown by the later Precambrian rocks of the Minto Arch are two, broad, gentle folds. The northerly fold, the Walker Bay anticline, parallels roughly the north side of Minto Inlet. It strikes about easterly from Walker Bay on the west coast of Victoria Island. The plunge appears to be westerly. Dips along the flanks are 5 degrees or less. The complementary Holman Island syncline is more extensively exposed. It may be traced, as a broadly curving structure from about Holman Island on the west coast to near the entrance to Hadley Bay on the north coast, and appears to plunge gently to the southwest. Dips of the later Precambrian rocks along the flanks of the Holman Island syncline are generally less than 5 degrees, but dips up to 10 degrees are found in the vicinity of Wynniatt Bay on the north coast of the island.

The angular discordance between the Palæozoic and the Precambrian rocks of the Minto Arch demonstrates that the Walker Bay anticline and the Holman Island syncline were folded prior to deposition of the earliest Palæozoic rocks in the area. Later crustal movements, however, are clearly responsible for the present position of the Minto Arch as a structural high, or uplift, with homoclinal sequences of Palæozoic rocks dipping away from the Arch. There is no evidence in the stratigraphic column of the map-area to suggest that the Minto Arch underwent sudden uplift at any time. The essentially homoclinal sequence of Upper Cambrian (?) to Upper Devonian strata that extends through Prince Albert Peninsula into northeast Banks Island presumably developed as a result of the positive movement that effected the Minto Arch. The uplift is, therefore, presumably Upper Devonian or later. Lower Cretaceous rocks rest unconformably upon the Palæozoic strata (*see* above) and this suggests that the uplift of the Minto Arch took place prior to the Lower Cretaceous.

The Boothia Arch, east of the map-area, is known to have moved positively, and relatively violently, in late Silurian or early Devonian time (*see* Thorsteinsson and Tozer, 1960). Latest Silurian and early Devonian rocks are not exposed on Victoria Island; consequently there is no record of events for this period. It is conceivable that the Minto Arch moved in late Silurian or early Devonian time (i.e., at the time of movement of the Boothia Arch), but this is improbable.

South Victoria Island. Several inliers of later Precambrian rocks are scattered over a relatively large area of south Victoria Island. Most of these are small, but two occupy relatively large areas. One includes the Richardson Islands, immediately off the south coast, and neighbouring regions of Victoria Island, the other forms a linear belt that extends northwesterly from Wellington Bay toward the geographic centre of the Island. The rocks of all these inliers are provisionally correlated with the Glenelg Formation, the basal unit of the Shaler Group. Fortier, *et al.* (1954) suggested that the Precambrian outcrops at Wellington Bay constituted a Precambrian arch to which they gave the name Wellington Arch. However, evidence obtained by the present survey suggests that all the inliers of Precambrian rocks in south Victoria Island, including those of Wellington Bay, are exhumed topographic highs on the Precambrian surface. As near as can be determined the Precambrian rocks in south Victoria Island are flat lying. If the beds are not horizontal, they dip so gently that their dips cannot be measured by eye. Bedding, which is horizontal or nearly so, appears to characterize the Palæozoic rocks immediately adjacent to the Precambrian exposures. Moreover, with the exception of the periphery of the Precambrian rocks of the Richardson Islands, map-unit 10a is absent or sporadically developed at the exposed contacts of the Precambrian inliers. In several areas flat-lying dolomite of map-unit 10b appears to abut directly against the steeply dipping erosional surface on Precambrian outcrops.

South Banks Island. Precambrian rocks that are provisionally assigned to the Glenelg Formation of the Shaler Group outcrop in five separate areas in south Banks Island. The largest of these forms a belt of sea-cliffs that rims the southern extremity of the island. Four small inliers assigned to the Glenelg Formation[1] lie scattered in the country to the north of the sea-cliffs. In this region the Precambrian rocks are overlain unconformably by Lower Cretaceous beds. The Precambrian rocks in the sea-cliffs are cut by several, northerly trending, normal faults. Most of these faults have very small displacements, but one north-south striking normal fault east of Nelson Head apparently brings Tertiary rocks into juxtaposition with Glenelg rocks.

The structural relationships of the isolated Precambrian inlier of south Banks Island are not readily apparent. The proximity of south Banks to the Minto Arch of northwest Victoria Island, together with the probability that correlative rocks are involved, might lead to the suggestion that two regions are structurally related. However, another structural relationship for this Precambrian inlier, suggested by Thorsteinsson and Tozer (1960), seems more probable. The writers have suggested that the Precambrian inlier of south Banks Island is related to the Prince Patrick uplift, a major structural feature involving two areas to the north: southeast Prince Patrick Island; and the Cape Crozier anticline in north Banks Island. The writers have suggested that all three regions may represent culminations along a largely buried structural feature comparable to the Minto and Boothia Archs. The reasons for this suggested relationship are as follows: all three regions lie on strike with one another; all three are characterized by north-trending structures; and all three regions appear to have been tectonically active in Tertiary time and probably also in the Mesozoic. The attenuated Lower Cretaceous sequence preserved in the graben between Nelson Head and Cape Lambton suggests that southernmost Banks Island was a tectonically positive area in Lower Cretaceous time (*see* p. 63). Possibly the Precambrian inlier of the Darnley Bay area (*see* O'Neill, 1924, p. 37A) is the southern extension of this uplift.

[1] It should be noted that in both south Banks Island and south Victoria Island certain inliers are composed of gabbro only. For reasons mainly of convenience, these gabbro inliers are referred to in this report and mapped as the Glenelg Formation.

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Arctic Lowlands

The Arctic Lowlands province embraces the regions of the Arctic Archipelago where thin, generally flat-lying-to-gently-dipping Palæozoic and Mesozoic rocks overlie the shield. The Arctic Lowlands are situated between exposures of the Canadian Shield and the Franklinian geosyncline, and as such they represent the counterpart of the Interior Lowlands of the continental mainland. Most of Banks and Victoria Islands and all of Stefansson Island lie within the Arctic Lowlands. The development of the Minto Arch, described above, has resulted in the subdivision of the Arctic Lowlands into several more or less discrete structural elements. These are discussed below.

Prince Albert Peninsula and Northeast Banks Island. This area constitutes the Prince Albert homocline of Thorsteinsson and Tozer (1960). Sedimentary rocks of Ordovician, Silurian, and Devonian age form an apparently conformable succession, with the younger beds appearing to the northwest. This stratigraphic relationship suggests that from a structural standpoint this terrain is essentially a northwesterly dipping homocline. This impression is confirmed by prevailing northwesterly dips in the country north of Walker Bay on Victoria Island as well as in northeastern Banks Island (see Pl. XXIII) and elsewhere. However, in detail the structural picture is certainly more complex. There are dip reversals in map-unit 10b south of Richard Collinson Inlet, in the Devonian rocks on the southeast side of Prince of Wales Strait, and in northeastern Banks Island. The scattered nature of the outcrops in this area makes it difficult to assess the importance of these dip reversals. Probably they indicate undulations and faults superimposed upon the Prince Albert homocline.

Stefansson Island. Most of this island exposes gently north-dipping Ordovician (?) and Silurian rocks. In the northwest corner of the island there is an east-trending structure, apparently a faulted anticline.

Southwest Victoria Island. Included in this region are Palæozoic sediments that lie south of the Minto Arch and west of an arbitrary line that joins the head of Hadley Bay with the Precambrian rocks of Wellington Bay on the south coast. Fortier, *et al.* (1954) assumed that this region was occupied by a basin to which they applied the name Wollaston Basin. The present study has neither confirmed nor negated this assumption. Reconnaissance study of the exposed rock suggests that the entire region is underlain by a nearly completely horizontal Palæozoic bed of map-units 10a and 10b. If there is a basinal structure in this area it is probably shallow. As already noted (*see* p. 41), the thickness of Palæozoic strata in this area is at least 800 feet.

East Victoria Island. For present purposes this region may be defined as the part of Victoria Island east of a line joining the head of Hadley Bay with the Precambrian rocks of Wellington Bay. The state of present knowledge of this region is comparable to that of the southwest region of Victoria Island which was described under the foregoing heading. East Victoria Island is underlain by map-units 10a and 10b, which appear to be flat lying. Fortier, *et al.* (1954) suggested that this region of Victoria Island formed the western part of a north-trending basin bounded on the east by Boothia Arch. Information obtained by the present study has brought no new information to bear upon this suggested structure. However, an aeromagnetic profile along a west-east line extending from the head of Hadley Bay to Prince of Wales Island lends support to the suggested possibility of a basin in this region. Interpretation of aeromagnetic data (*see* Gregory, *et al.*, 1960) indicated basement exposed west of the head of Hadley Bay, this prognosis has been confirmed from outcrops (see p. 24); 600 to 900 feet to basement near the centre of Storkerson Peninsula, Victoria Island; basement depth of about 4,500 feet a short distance off the east coast of Victoria Island, in M'Clintock Channel; and 10,000 feet to basement in the west-central coastal region of Prince of Wales Island. It should be noted, however, that the thicknesses given above may include that of stratified late Precambrian rocks as well as Palæozoic strata.

Lower Cretaceous to Early Tertiary terrain of Banks Island. A major unconformity underlies the succession of Lower Cretaceous to early Tertiary beds on Banks Island. In northeast Banks Island this succession rests on the Upper Devonian, whereas in the south of the island it rests on Precambrian rocks. Although much of the Lower Cretaceous to early Tertiary succession in central region of the island is covered by younger deposits, the strike of Lower Cretaceous to early Tertiary beds appears to circumscribe a broad, open basin whose axis strikes and plunges northwesterly. This structure has been named the Banks Island Basin (*see* Thorsteinsson and Tozer, 1960).

Prince Patrick Uplift

Northern extremity of Banks Island. Thorsteinsson and Tozer (1960) have applied the term Prince Patrick uplift to a region that includes a large inlier of Devonian rocks in southeast Prince Patrick Island, and another but smaller inlier of Devonian rocks near the northern extremity of Banks Island. These inliers lie on strike with one another and each is characterized by north-trending normal faults. On Prince Patrick the normal faults displace rocks as young as Lower Cretaceous, and on Banks the one normal fault dislocates rocks of early Tertiary age.

The Devonian inlier in north Banks Island is exposed along the axis of a northerly trending, symmetrical anticline. Thorsteinsson and Tozer (op. cit.) have named this structure the Cape Crozier anticline. The Cape Crozier anticline appears to plunge gently to the south and the limbs of the anticline dip gently away from the axis. Unlike other regions of Banks Island in which the Lower Cretaceous Isachsen Formation represents the basal deposits of the Lower Cretaceous to early Tertiary transgressive sequence, the Isachsen Formation is absent in the Cape Crozier anticline and the Lower Cretaceous Christopher Formation lies unconformably on Devonian rocks. The absence of the Isachsen Formation suggests positive movement of the Prince Patrick uplift within the Cretaceous. That the

Prince Patrick uplift did experience tectonism throughout the Mesozoic is borne out by geological relations on Prince Patrick Island (*see* Thorsteinsson and Tozer, 1960). The possibility that the Prince Patrick uplift and the region of Precambrian exposures in south Banks Island are genetically related, and that these structures represent culminations along a largely buried Precambrian arch have already been discussed (*see* p. 73).

Arctic Coastal Plain

West Banks Island. The Arctic Coastal Plain includes some of the western regions of Banks Island that are underlain by the Beaufort Formation, which ranges from late Tertiary to early Pleistocene. Although in this region the Beaufort Formation is largely masked by glacial deposits, its structural relations appear to be relatively simple. Beaufort beds lie unconformably on rocks of Lower Cretaceous to early Tertiary age. The regional strike of the formation is about northeasterly, roughly parallel to the west coast of Banks Island. Throughout its extent, the Beaufort Formation and the plain developed on it slope gently toward the Beaufort sea.

Chapter V

ECONOMIC GEOLOGY

Copper

A few small specks and flakes of native copper, none exceeding 3 mm in any dimension, were observed in the volcanic rocks of the Natkusiak Formation. The native copper occurs in the basalt flows as disseminated particles, and in thin calcite veins and calcite-filled vugs and pores in the agglomerate which, in places, forms the base of the formation. Copper-bearing minerals associated with native copper in the agglomerate include cuprite, tenorite, malachite, and chrysocolla. No other formations were found to contain mineralized zones. Efforts to locate economic copper deposits in the map-area should first be concentrated in the region underlain by the Natkusiak Formation.

The occurrence of native copper on Victoria Island was first reported by V. Stefansson (1913, p. 294) on the basis of reports given to him by Eskimos in Prince Albert Sound. According to the Eskimos, they obtained native copper from mountains northeast of the head of Prince Albert Sound where it occurred in masses, "... as high as a man's shoulder and as wide as high; others project from the hillside and are of uncertain size". Later O'Neill (1924, p. 54A) received similar reports of copper northeast of Prince Albert Sound from Eskimos on the mainland. Jenness (1922, p. 41) reports "Two families of Prince Albert Sound natives whom I met in the summer of 1915 ... said that the main body of their people had gone to a lake called Tahiryuak close to some copper deposits a day's journey northeast of the sound". Lake Tahiryuak is, in fact, about 40 miles north-northwest of the head of Prince Albert Sound.

The general similarity of these reports on the location of native copper deposits suggests authenticity. Further credence is lent to these accounts by the present survey's discovery of copper minerals in the Natkusiak Formation, which outcrops in the general region from which the Eskimos claimed to have obtained copper.

The authors questioned several Banks and Victoria Islands Eskimos concerning the occurrence of native copper. Most were aware of the presence of copper deposits on Victoria Island, either through information passed on to them by their forefathers or through conversations with their friends; all gave the general location of the native copper deposits as several miles east of the head of Minto Inlet. A glance at a map of Victoria Island is sufficient to indicate that such a location may well coincide with that of copper deposits reported by Eskimos to Stefansson, O'Neill, and Jenness. One Eskimo only claimed to have personally observed native copper in rock. When asked to locate the occurrence on a map he made a point at about latitude 71°31′, longitude 113°21′, which lies within the outcrop area of the Natkusiak Formation.

Although there is a good possibility that fairly large masses of native copper are present on Victoria it should be noted that (1) there is no information to suggest that such deposits are of economic importance; (2) prior to the present report, there is no record of any competent observer having seen native copper *in situ;* and (3) as the whole of Victoria Island has been glaciated by ice originating on the continental mainland, there is a possibility that masses of native copper, if they do exist on Victoria Island, were transported to their present position.

Oil and Gas

The geological information obtained by the present survey suggests that certain regions of the map-area are more promising for oil and gas accumulations than others. The relative merits of four, somewhat arbitrarily defined regions are outlined briefly below. Several statements in this discussion are admittedly speculative.

1. The potential oil- and gas-bearing rocks in regions of Victoria Island that lie to the south, southeast, and east of the Minto Arch are represented by map-units 10a and 10b of early Palæozoic age. Both formations contain potential reservoir beds. Map-unit 10a is commonly characterized by clean, well-sorted sandstone beds some of which appear to possess both porosity and permeability. Many beds of dolomite in map-unit 10b are characterized by intergranular and vuggy porosity, and certain very porous and massive rocks may represent reefs. Jointing, which is especially well developed in the Palæozoic carbonate and sandstone formations in the map-area, provides additional porosity and permeability. There is good evidence that the Precambrian surface (over which the vast cover of Palæozoic rocks lie) was highly irregular and the possibility of closed structures over topographic highs on the Precambrian is worthy of special consideration. However, characters that may be regarded as militating against the possibility of oil and gas in commercial quantities in this region appear to outweigh the favourable characters outlined above. The aggregate thickness of potential oil- and gas-bearing rocks is small. The maximum exposed thickness of map-unit 10a in this region is about 150 feet. The only other possible oil- and gas-bearing rocks are those of map-unit 10b, and nowhere in this region is there a complete section of this formation. The thickness of map-unit 10b throughout the greater part of this region is believed to be less than 1,000 feet, but it possibly may reach about 2,000 feet in the vicinity of the east coast of Victoria Island. Another unfavourable character of this region may be the virtual absence of marine shale, which is commonly regarded as a likely source rock for hydrocarbons.

2. The possibility of oil and gas accumulations on Stefansson Island appears to be better than that of the region of Victoria Island described above. This opinion is based partly on the apparent greater thickness of Palæozoic cover, and

partly on theoretical considerations. The overall structure of Stefansson Island is that of a homocline that dips gently to the north. Exposed bedrock includes map-unit 10b and three unnamed formations of the Middle to Upper Silurian Read Bay Group. Map-unit 10a or equivalent beds may occur in the subsurface. The presence of the Read Bay Group, in itself, adds little to oil and gas prospects of the island, as the total thickness of these rocks is small (about 675 feet) and they occupy a small part of the island. Possibly the faulted anticline structure of northwestern Stefansson Island represents a potential structural trap.

3. Regions of Prince Albert Peninsula of Victoria Island and northeast Banks Island, which are underlain by the northwesterly dipping homoclinal sequence of Palæozoic rocks, may represent the most favourable region of the map-area in which to prospect for oil and gas. Unfortunately the stratigraphic sequence on Prince Albert Peninsula is largely concealed by thick Pleistocene deposits. Nevertheless five map-units have been recognized and in northeastern Banks Island the thickness of Palæozoic rocks may reach 10,000 feet (*see* Gregory, *et al.,* 1960). The rocks of the Prince Albert homocline include: map-unit 10a (? Upper Cambrian age); map-unit 10b (Ordovician to Middle Silurian); the Read Bay Group (Middle and Upper Silurian); Blue Fiord Formation (Middle Devonian); and the Melville Island Formation (Middle and Upper Devonian). All five formations may contain reservoir rocks. The reservoir prospects of map-units 10a and 10b have already been discussed. The Read Bay Group, although mostly covered on Prince Albert Peninsula, is known to contain reefoid developments on Cornwallis Island (*see* Thorsteinsson, 1959). The Blue Fiord Formation is partly exposed only on Prince Albert Peninsula; it is widely distributed in the Queen Elizabeth Islands, where it is known to contain reefs as well as vuggy dolomite. The exposures on the Princess Royal Islands suggest that Middle Devonian reefs may occur in the Prince of Wales Strait (*see* p. 52). The shales on Prince Albert Peninsula that resemble the Eids Formation (*see* p. 50) and the argillaceous limestones of Princess Royal Islands are possible source beds for hydrocarbons. Silurian graptolitic shales, although not exposed, may be present in view of their occurrence on Stefansson Island. Moreover, given suitable structures these shales and argillaceous limestones might form effective barriers to the upward migration of hydrocarbons. Although the structure of the Prince Albert homocline is imperfectly exposed (*see* p. 74), there are certain dip-reversals in this area and it is possible that structural traps may exist beneath this essentially homoclinal terrain. The very brief examination of the spectacularly exposed limestone reef belt south of Mercy Bay indicated that porosity was poor. Nevertheless, these reefs may be significant from the point of view of oil and gas potential. The exposed reefs definitely seem to form a belt, which possibly continues to the south, beneath younger formations.

4. The oil and gas prospects of that region of Banks Island where Cretaceous and Tertiary rocks are exposed is difficult to evaluate. Probably the best prospects there are the Palæozoic rocks that undoubtedly underlie a part of this same region, but whose extent and character are unknown. It should be borne in mind that the

sub-Cretaceous geology is probably varied. From the occurrence of Precambrian immediately beneath the Cretaceous of Nelson Head, it is clear that the Prince Albert homocline does not extend, as a simple structure, beneath the Mesozoic of southern Banks Island. The Cretaceous and Tertiary beds are largely covered also by late Tertiary and Pleistocene sediments, and most of the Cretaceous and Tertiary beds are nonmarine. Nevertheless two factors lend some encouragement to the prospects of oil and gas in Cretaceous and Tertiary beds. (1) The Christopher shale is a potential source rock and the subjacent sands of the Isachsen and Eureka Sound constitute possible reservoir beds. (2) The possibility of a buried cratonic arch extending from the northern to the southern extremity of Banks Island has already been discussed (*see* p. 73). Such an arch may have exerted considerable influence on the structure and stratigraphy of the Cretaceous and Tertiary rocks and there may be concealed structural 'highs' between Cape Crozier and Nelson Head.

BIBLIOGRAPHY

Armstrong, Alexander
1857: A personal narrative of the discovery of the Northwest Passage; London, *Hurst and Blackett,* 616 pp.

Amundsen, Roald
1908: The Northwest Passage; London, *Archibald Constable and Co. Ltd.,* 2 vols.

Blackadar, R. G.
1958: Foxe Basin North, District of Franklin, Northwest Territories; *Geol. Surv., Canada,* Map 4-1958.

Cloud, P. E.
1942: Notes on Stromatolites; *Am. J. Sci.,* vol. 240, pp. 363-379.
1945: The Stromatolite Gymnosolen not a Salinity Index; *Am. J. Sci.,* vol. 243, p. 108.

Collinson, Richard
1889: Journal of H.M.S. *Enterprise,* on the expedition in search of Sir John Franklin's ships by Behring Strait, 1850-1855; London, *Sampson, Low, Marston, Searls, and Rivington Ltd.,* 531 pp.

Craig, B. G., and Fyles, J. G.
1960: Pleistocene Geology of Arctic Canada; *Geol. Surv., Canada,* Paper 60-10, 21 pp.

Dunbar, M., and Greenaway, K. C.
1956: Arctic Canada from the air; *Canada Defence Research Board,* Queen's Printer, Ottawa, 541 pp.

Fortier, Y. O.
1948: Flights in 1947 over the Regions of the North Magnetic Pole and the mainland between the Arctic Coast, Great Slave Lake, and Hudson Bay, Northwest Territories; *Geol. Surv., Canada,* Paper 48-23.
1957: The Arctic Archipelago; *Geol. Surv., Canada,* Econ. Geol. Ser. No. 1 (4th ed.), pp. 393-442.

Fortier, Y. O., McNair, A. H., and Thorsteinsson, R.
1954: Geology and Petroleum Possibilities in Canadian Arctic Islands; *Bull. Am. Assoc. Petrol. Geol.,* vol. 38, pp. 2075-2190, figs. 1-4.

Fortier, Y. O., *et al.*
In press: Geology of the North-central part of the Arctic Archipelago, Northwest Territories (Operation Franklin); *Geol. Surv., Canada,* Mem. 320.

Franklin, John
1828: Narrative of a Second Expedition to the Shores of the Polar Sea in the years 1825, 1826, and 1827; London, *John Murray,* 320 pp. and appendix.

Gregory, A. F., Bower, Margaret E., and Morley, L. W.
1960: Geological Interpretation of Aeromagnetic Profile from the Canadian Arctic Archipelago; *Geol. Surv., Canada,* Paper 60-6.

Haughton, S.
1857: Geological Notes and Illustrations, *in* M'Clintock, 1857, pp. 238-250.
1859: Geological Account of the Arctic Archipelago; Appendix 4 *in* M'Clintock, 1859.

Heywood, W. W.
1955: Arctic Piercement Domes; *Trans. Can. Inst. Min. Met.,* vol. 58, pp. 27-32.
1957: Isachsen Area, Ellef Ringnes Island, District of Franklin, Northwest Territories; *Geol. Surv., Canada,* Paper 56-8, 36 pp., 9 pls., map.

Jenness, Diamond
1922: The Life of the Copper Eskimos; Report of the Canadian Arctic Expedition, 1913-18, vol. 12, Ottawa, 277 pp.
1959: The People of the Twilight (Second Edition); *Univ. Chicago Press,* 251 pp.

Larsen, H. A.

1945: Reports and other Papers Relating to the two voyages of R.C.M. Police Schooner "St. Roch" through the North West Passage, Ottawa, R.C.M.P., 95 pp.

MacKay, J. Ross

1958: The Anderson River Map-area, N.W.T.; *Geographical Branch, Mines and Tech. Surv.*, Ottawa, Mem. 5, 137 pp.

Manning, T. H.

1953: Narrative of an unsuccessful attempt to circumnavigate Banks Island by canoe in 1952; *Arctic (J. Arctic Inst. N. Amer.)*, vol. 6, pp. 170-197.

1956: Narrative of a second Defence Research Board Expedition to Banks Island, with notes on the country and its history; *Arctic (J. Arctic Inst. N. Amer.)*, vol. 9, pp. 3-77.

Manning, T. H., Hohn, E. O., and Macpherson, A. H.

1956: The Birds of Banks Island; *Nat. Mus., Canada,* Bull. 143, IV + 144 pp.

Manning, T. H., and Macpherson, A. H.

1958: The Mammals of Banks Island; *Arctic Inst. N. Amer.,* Tech. Paper 2, 74 pp.

McLaren, D. J.

1959: The Role of Fossils in Defining Rock units with Examples from the Devonian of Western and Arctic Canada; *Am. J. Sci.,* vol. 257, pp. 734-751.

M'Clintock, F. L.

1857: Reminiscences of Arctic Ice Travel in Search of Sir John Franklin and his Companions; *J. Roy. Soc. Dublin,* vol. 1, pp. 183-280.

1859: A Narrative of the Discovery of the Fate of Sir John Franklin and his Companions; London, *John Murray.*

Miller, A. K., and Youngquist, Walter

1947: Ordovician Fossils from the Southwestern Part of the Canadian Arctic Archipelago; *J. Palaeontology,* vol. 21, No. 1, pp. 1-186, 5 pls.

O'Neill, J. J.

1924: Geology of the Arctic coast of Canada, west of the Kent Peninsula; *Rept. of the Canadian Arctic Expedition 1913-18,* vol. 11, Geology and Geography, part A., Ottawa, 107 pp.

Osborn, Sherard

1856: The Discovery of the North West Passage by H.M.S. *Investigator,* Capt. R. M. McClure, 1850-1851-1853-1854; London, *Longman Brown, Green, Longmans, and Roberts,* 405 pp.

Parry, W. E.

1821: Journal of a voyage for the discovery of a North West Passage from the Atlantic to the Pacific performed in the years 1819-20 in H.M.S. *Hecla and Griper;* London, *John Murray,* 2nd ed., 310 pp.

Porsild, A. E.

1950: A Biological Exploration of Banks and Victoria Islands; *Arctic (J. Arctic Inst. N. Amer.)*, vol. 3, pp. 45-54.

1955: The Vascular Plants of the Western Canadian Arctic Archipelago; *Nat. Mus. Can.,* Bull. No. 135, Biol. Ser. No. 45, 226 pp.

Rae, John

1852: Journey from Great Bear Lake to Wollaston Land and Recent explorations along the south and east coasts of Victoria Land; *J. Roy. Geog. Soc.,* vol. 22, pp. 73-96.

Rowley, Diana

1952: Stefansson Island; *The Arctic Circular,* vol. 5, No. 5, pp. 44-53, 2 figs.

Simpson, Thomas

1843: Narrative of the discoveries on the north coast of America; effected by the officers of the Hudson's Bay Company during the years 1836-39; London, *Richard Bentley,* 419 pp.

Stefansson, V.

1913: My Life with the Eskimo; New York, *Macmillan Company,* 538 pp.

1921: The Friendly Arctic, the story of five years in polar regions; New York, *Macmillan Company,* 784 pp.

Thorsteinsson, R.

1959: Cornwallis and Little Cornwallis Islands, District of Franklin, Northwest Territories; *Geol. Surv., Canada,* Mem. 294, 134 pp., 8 pls., 5 figs., map.

1960: The history and geology of Meighen Island; *Geol. Surv., Canada,* Bull. 75.

Thorsteinsson, R., and Fortier, Y. O.

1954: Report of progress on the geology of Cornwallis Island, Arctic Archipelago, Northwest Territories; *Geol. Surv., Canada,* Paper 53-24, pp. 1-25, map.

Thorsteinsson, R., and Tozer, E. T.

1957: Geological Investigations in Ellesmere and Axel Heiberg Islands, 1956; *Arctic (J. Arctic Inst. N. Amer.),* vol. 10, No. 1, pp. 1-31.

1959a: Western Queen Elizabeth Islands, District of Franklin, Northwest Territories; *Geol. Surv., Canada,* Paper 59-1.

1959b: Geological Investigations in the Parry Islands, 1958; *The Polar Record,* vol. 9, No. 62, pp. 458-461, 1 pl.

1960: Summary account of structural history of the Canadian Archipelago since Precambrian time; *Geol. Surv., Canada,* Paper 60-7.

Tozer, E. T.

1956: Geological reconnaissance, Prince Patrick, Eglinton and Western Melville Islands, Arctic Archipelago, Northwest Territories; *Geol. Surv., Canada,* Paper 55-5, 32 pp.

1960: Summary account of Mesozoic and Tertiary stratigraphy, Canadian Arctic Archipelago; *Geol. Surv., Canada,* Paper 60-5, 24 pp.

Troelsen, J. C.

1950: Contribution to the geology of northwest Greenland, Ellesmere and Axel Heiberg Islands; *Medd. om Grønland,* vol. 147, No. 7, 85 pp.

1952: Geological investigations in Ellesmere Island, 1952; *Arctic (J. Arctic Inst. N. Amer.),* vol. 5, pp. 199-210.

Washburn, A. L.

1947: Reconnaissance geology of portions of Victoria Island and adjacent regions Arctic Canada; *Geol. Soc. Amer.,* Mem. 22, 142 pp.

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