Eug. Poitevin

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 53-24

REPORT OF PROGRESS
ON THE
GEOLOGY OF CORNWALLIS ISLAND, ARCTIC ARCHIPELAGO, NORTHWEST TERRITORIES

(Report and Map)

By

R. Thorsteinsson and Y. O. Fortier

OTTAWA
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CONTENTS

Illustrations

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INTRODUCTION

Location

The centre of Cornwallis Island is about latitude 75°15' north and longitude 95°00' west, which locates it near the geographic centre of the Arctic Archipelago. The island, some 2,850 square miles in area, is approximately 75 miles along its greatest dimension and 60 miles across at its widest point.

Present Investigation and Acknowledgments

Reconnaissance of the geology of Cornwallis Island was initiated by the Geological Survey of Canada in the summer of 1950, when Fortier and Thorsteinsson, in association with T. A. Harwood (1951)[1] of Defence Research Board, cruised by canoe around the coasts of the island. Thorsteinsson continued the survey in the summers of 1951 and 1952. This paper is a report of progress on the geology of the coastal region only.

Transportation to and from Cornwallis Island was provided by the Royal Canadian Air Force, which service is gratefully acknowledged. On a few occasions transportation was on aircraft of the United States Air Force, to whom also the authors are indebted. The Weather Station at Resolute Bay was used as a main base by the field parties. Its facilities were put at their disposal by the authorities of the Meteorological Division of the Department of Transport and of the United States Weather Bureau, joint operators of the station. It is a pleasure to acknowledge these services and also the many courtesies rendered by the above authorities and the personnel of the weather station, and the interest all have taken in the present investigation.

Brian MacLean and A. Orr, in 1951, and Robert Daw, Lloyd Avery, and Arthur Vardy, in 1952, ably assisted Thorsteinsson.

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[1] Dates in parentheses are those of references listed on page 5.

History of Discoveries

Cornwallis Island was discovered in 1819 by Captain (later Admiral Sir) W. E. Parry. In search of a Northwest Passage, Parry sailed west to Melville Island through the series of sounds and straits at the latitude of Lancaster Sound, discovering and naming Cornwallis and the many other islands on his route.

Cornwallis Island was first circumnavigated by Sir John Franklin in 1845. This information on the ill-fated expedition is contained in a message found on King William Island, in which it is stated that Franklin, before wintering at Beechy Island off the south-west coast of Devon Island, had ascended Wellington Channel in 1845 to latitude 77 degrees and returned on the west side of Cornwallis Island.

Much of the shoreline of the island was charted during the search for Franklin, when three British naval squadrons, under Captain H. T. Austin, Captain W. Penny, and Captain Sir John Ross, respectively, established winter quarters for 1850-51 off Cape Martyr and in Assistance Bay. From these bases, members of the expeditions explored, among others, the coasts of Cornwallis Island.

The Geological Survey field parties have found three messages left by those expeditions. One (Plate I), signed by Ross himself, was in a cairn on Prospect Hill, near Assistance Bay; a second one (Plate II), signed by Shellabear, a member of Penny's expedition, was found in a bottle in a stream at the head of Barlow Inlet; the third one (Figure 1) is a note left by a member of Penny's squadron to which two others had apparently been added in 1853 by Captain W. J. S. Pullen's party. These notes, wrapped in a newspaper, were in a rusty tin can that, with many others, lay on the ground at Decision Point. A whaleboat, abandoned by Penny, was also found in Abandon Bay on the northeast coast of the island. On the east shore of Assistance Bay heaps of tin cans and many iron spearheads were found strewn on the ground, possibly where a blacksmith had his anvil. These weapons probably belonged to members of Penny's crew.

Between the end of the search for Franklin and 1947 the south coast of Cornwallis Island received few visitors, and the east and northern coasts in particular were only travelled on rare occasions by the Royal Canadian Mounted Police. In the summer of 1947 the Weather Station at Resolute Bay was established.

The Geological Survey party of 1950 was probably the first one to follow the coast all around Cornwallis Island and to navigate the strait between that island and a small one to the north-west of it, "Little Cornwallis" Island; it certainly was the first to bring back record of such a trip. Thorsteinsson, in 1952, was the first to set foot on "Little Cornwallis" Island.

Previous Geological Investigation

No geologist had previously visited these parts and no geological map or report existed. On small scale, regional geological maps, Cornwallis Island has been shown underlain by Silurian strata and "Little Cornwallis" Island by Carboniferous. This was based on small fossil collections made, during the search for Franklin, in Assistance Bay and at Cape Hotham on Cornwallis Island, and in McDougall Sound west of the island.

Accessibility and Method of Travel

Cornwallis Island is accessible by aircraft the year round and by ship for part of the summer.

The Geological Survey parties used a 22-foot freighter canoe with a 5 H.P. outboard motor in travelling along the coasts. They circumnavigated the island in 1950 and were able to reach any part of the coast in both subsequent years; in 1952, Thorsteinsson reached most of the coast of "Little Cornwallis" Island. The advantage of a light craft for such work is the ease with which it can be pulled onto the shore out of the way of shifting fields of pan ice.

Vegetation and Game

Cornwallis Island is nearly barren of vegetation. Uplands 300 feet or more above sea-level show none except for few small patches commonly lying on the summits of hills. Grass, moss, and other plants are more plentiful in small areas, rarely exceeding a few acres, in some broad valley floors and in some lowlands. Certain types of bedrock, for instance calcareous shale, argillaceous limestone, and calcareous sandstone, seem to favour vegetation, whereas limestone and dolomite generally are bare. As the latter rocks predominate, the surface of the island is drab, grey, and greyish yellow, the colour of these rocks and of the mantle (till, regolith, beach deposits) that is derived principally from bedrock.

Musk-ox, caribou, fox, and hare were seen in the course of survey work, and polar bears were a common sight on beaches or on pan ice. Whales were observed along the east and south coasts of the island. Walrus were seen in the strait separating "Little Cornwallis" Island from Cornwallis Island, but they were especially abundant in Allen Bay. Arctic char were caught along the east coast of the island.

Climate

Comments and figures on the climate of the Archipelago have been published by R. W. Rae (1951), from which the following figures for Resolute are taken:

DATA ON CLIMATE AT RESOLUTE

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Range
Monthly and annual averages of daily mean temperatures (°F.)		-30	-34	-23	-13	13	33	40	38	23	6	-8	-19	2	74
Monthly and annual averages of daily maximum temperatures (°F.)		-23	-27	-16	-4	20	37	46	42	27	12	-1	-14	8	73
Monthly and annual averages of daily minimum temperatures (°F.)		-36	-41	-31	-21	6	29	35	33	19	0	-14	-26	-4	76
Averages of monthly and annual rainfall (inches)		0	0	0	0	0	0.38	1.19	0.72	0.39	0	0	0	2.68	
Averages of monthly and annual snowfall (inches)		0.7	1.4	2.0	1.3	6.2	3.0	0.5	3.1	7.9	5.7	2.7	1.0	35.5	
Cloudiness in days per month	0-20 per cent	20	15	17	15	8	3	4	5	3	7	11	19		
	30-70 per cent	4	3	4	3	4	4	4	4	2	4	4	3		
	80-100 per cent	7	10	10	12	19	23	23	22	25	20	15	9		

Topography and Drainage

Cornwallis Island can be divided into two types of topography, of different relief and stages in the erosion cycle.

The longer part of a plateau, which is the result of advanced peneplanation effected at some early time, lies in the south-eastern part of the island. The plateau has an average elevation of some 1,000 feet, but its surface is undulating and is truncating strata of many structures. A height of 1,350 feet, measured by aneroid, 7 miles southeast of Read Bay is, in all likelihood, the highest point on the island. The surface of the plateau is crossed by streams separated by large intervening areas, apparently devoid of drainage lines. The streams are extending headward and down-cutting, as, for instance, a stream canyon 350 feet deep north of Assistance Bay.

The east coast is remarkably straight over long distances, especially where it follows the strike of inclined bedrock strata. Heights up to 900 feet above what is thought to be high tide marks occur close to the coast, and yet vertical cliffs are rare as the coast slopes down to sea along the dip of strata that varies from gentle up to 45 degrees from the horizontal.

The remainder of the island is made of the second topographic type. In all directions, but especially west and north, away from the plateau, the elevation above sea-level decreases and dissection of the land increases. It is in these parts that the largest streams occur. The dissection and partial submergence of the island have resulted in most of the western half of the island having an irregular coast-line. Near this western coast are low-lying plains with gentle slopes.

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STRATIGRAPHY

General Statement

The greater part of the bedrock exposed in the traversed region of Cornwallis and "Little Cornwallis" Islands is of marine origin and ranges in age from Late Ordovician through the Silurian and into the Devonian. Carbonate sediments are the preponderant rock types. Two younger formations, widely separated and represented by single outcrop areas, rest with angular unconformity upon Lower Palaeozoic rocks. Neither has yielded fossils. One consists chiefly of dolomite and limestone conglomerate and may be Late Palaeozoic or Mesozoic in age; the other, represented by unconsolidated clastic sediments and by coal seams, is probably of Cretaceous or Tertiary age. Thus both continental and marine sediments are represented in an exposed aggregate section roughly 17,000 feet thick. Structural interpretation indicates that still older beds may be exposed in the unexplored interior of the island. The rocks are unaltered.

Ordovician and Silurian facies changes are manifest north and south of a zone trending somewhat south of west and dividing the island approximately in two. Broadly speaking, a graptolite, nautiloid, and radiolarian facies lie north of this zone and a shelly and reef facies lie to the south. Thus in the north, softer, dark greyish coloured shales and shaly limestones prevail in the outcrops, whereas to the south, harder light greyish yellow and yellowish grey limestones and dolomites outcrop almost exclusively. Doubtless this division is responsible for the contrasting physiography: the greatest relief and most of plateau remnants being found today in the southeast part of Cornwallis Island whereas the lower, more mature topography occurs in the northwest part.

Bedrock is generally well exposed along the sea-coast, in canyons, and in the deeper streams, but less so in the region of low relief to the northwest. Outcrops are sufficiently numerous and continuous to establish a virtually complete stratigraphic column with more detailed mapping, and thus to resolve the many problems of facies change on the two islands of Cornwallis and "Little Cornwallis".

The present report must be regarded as preliminary; several relationships are still not too clearly understood. The numerous fossil collections other than the graptolites (still incompletely studied) have only received cursory examination. The complexities of complete facies development and the fact that the interior of the island has not yet been explored prevent a more exact treatment of the geology at this stage of investigation.

Table of Formations

Period (identifications for the most part tentative)	Formation and approximate thickness (feet)	Lithology
Quaternary		Till and marine beach deposits
	Disconformity	
Cretaceous or Tertiary ?	Intrepid Bay 2,000±	Sand, clay, coal
	Disconformity	
Late Palaeozoic or Mesozoic ?	Disappointment Bay 80+	Limestone conglomerate, sandstone, dolomite
	Angular unconformity	
Devonian	Snowblind Bay 800+	Limestone breccia, limestone conglomerate, sandstone, siltstone
Ordovician and Silurian	Read Bay 8,500±	Limestone, argillaceous limestone, calcareous shale, shale, sandstone, siltstone
Ordovician(?) and Silurian	Allen Bay 5,500±	Dolomite; minor limestone
Ordovician	Cornwallis 150+	Limestone and shale
	Undifferentiated	Limestone, dolomite, dolomitic limestone, argillaceous limestone

Ordovician

Cornwallis Formation

The Cornwallis formation, named from the island, is conformable beneath Allen Bay strata at two localities. These are about 2 miles east of the head of Intrepid Bay and 8 miles west of Read Bay, where respectively a thickness of 67 feet and approximately 150 feet of Cornwallis formation outcrops. At both localities the succession of beds and their lithology are similar. The top member is a 28-foot thick stratum of greyish green plastic shale, bearing calcite concretions. This overlies light grey to olive-grey, fine-grained to lithographic, hard to soft, in part rubbly weathering, limestone and argillaceous limestone. The base of this formation has not been observed.

The Cornwallis formation is richly fossiliferous, bearing chiefly corals, trilobites, gastropods, nautiloids, and bryozoans, Cursory examination of this fauna indicates a Late Ordovician age.

Undifferentiated

On "Little Cornwallis" Island and adjacent parts of Cornwallis Island the dark-coloured graptolitic facies of the Read Bay formation, containing an Upper Ordovician fauna, overlies several hundred feet of greyish yellow to yellowish grey, light to medium dark grey, light olive-grey to olive-grey, fine-grained to lithographic, hard, dense, very thin-bedded, flaggy limestone, dolomite, dolomitic limestone, and argillaceous limestone. Certain strata are rich in fossils and cursory examination of them suggests a Late Ordovician age. Moreover, certain forms appear to be conspecific with fossils from the Cornwallis Island formation. Because of the uncertain stratigraphic position of these beds, they are mapped as "undifferentiated" Ordovician.

Ordovician(?) and Silurian

Allen Bay Formation

This name is applied to a succession of dolomite beds widely exposed in the southern parts of the island and resting, with a distinct yet conformable contact, on the Cornwallis formation. Particularly good exposures are to be found in the type locality at Allen Bay. There a thickness of 4,800 feet was measured by means of plane-table from the upper contact with the Read Bay formation to the fault near the axis of the Allen Bay anticline. Graphic measurements suggest a thickness of about 5,500 feet for this formation.

The Allen Bay formation comprises a series of generally greyish yellow, yellowish grey, light grey to medium grey, very thick- to thin-bedded, massive to slabby, fine-grained to coarse-grained dolomite. Highly porous strata are locally abundant, particularly in the vicinity of Resolute Bay, and porous strata, bearing much solid bitumen, have been observed outcropping along the axis of the Allen Bay and Resolute Bay anticlines. Limestone is only present locally. Beds of Allen Bay formation generally weather to saccharoidal masses on gentle slopes, whereas cliff faces may weather with characteristic lattice or pock-marked patterns. Weathering colours are in general greyish yellow to yellowish grey.

Well-preserved fossils are extremely scarce in the Allen Bay formation. Recognizable fossils are generally restricted to casts, but locally biostromes bearing silicified fossils may be found in which stromatoporoids and colonial corals are chiefly represented. Coquina of Conchidium knighti (Sowerby) is frequently observed in the upper few hundred feet of this formation.

Preliminary examination of Allen Bay faunas indicates a tentative Early Silurian age, but the formation may include strata of Late Ordovician age. A stratum bearing ostracoderm plates outcrops in the upper few feet of Allen Bay beds on Shellabear Creek, which flows into Barlow Inlet. The same species occurs at Disappointment Bay, on the northeast coast, in graptolitic facies of lowermost Wenlock age according to British stratigraphic terminology.

Ordovician and Silurian

Read Bay Formation

The Read Bay formation, comprising chiefly limestone, argillaceous limestone, calcareous shale, shale, and sandstone, lies in conformable and gradational contact with the underlying Allen Bay dolomite. The lower contact can generally be placed by testing for lime with acid and by the evident scarcity and generally poor preservation of fossils in the Allen Bay formation. Exposures are numerous over large areas of the island. Particularly good exposures are found along the eastern coastal region where there is a complete section near Read Bay, the type locality. At this place graphic measurements indicate a thickness of approximately 8,500 feet.

Areally the Read Bay formation is represented by three facies, all of which in the present report are referred to under one formational name. Along the east coast these three facies may be delineated as follows: (1) a shelly facies south of Snowblind Bay; (2) a graptolitic facies to the north of Helen Haven; and (3) an intervening reef facies near Cape De Haven. Between Cape Airy

and Stanley Head, along the southwestern coast of Cornwallis Island, the shelly and graptolitic facies may be again recognized, but the intervening reef facies is absent. Thus the shelly facies characterizes the Read Bay formation in about the southern half of the island and the graptolitic facies in the north half.

On the basis of lithology, the generally richly fossiliferous shelly facies(1) may be divided into four units as follows:

(a) The lower 1,875 feet, measured by plane-table on Goodsir Creek, are a light to medium dark grey, light olive-grey to olive-grey, fine-grained to lithographic, hard, dense, very thin-bedded, in part laminated, flaggy limestone. Bedding planes are commonly marked by shale partings. Although fossils are generally scarce, brachiopods, gastropods, and ostracods may be locally abundant. These strata alternate with limestone, generally brownish grey, medium grey to rusty red, very thick-bedded to thick-bedded, massive to blocky, fine- to coarse-grained, and commonly porous. These limestones are rarely dolomitic and generally biostromal. Stromatoporoids and colonial corals constitute the principal fossils. Crinoid fragments, trilobites, bryozoans, and gastropods may be locally abundant. Strata of this lithology vary from a few inches to 20 feet in thickness. Heterostracan (ostracoderm) plates are numerous near the base of the unit.

Monograptus bohemicus (Barrande), apparently the only graptolite to occur south of the reef facies, forms a well-marked zone in the upper beds of this unit. It occurs in the Lower Ludlow of Great Britain.

(b) A greenish black to black, friable shale, 60 to 100 feet thick, overlies unit (a). Locally the upper 30 feet of this unit consists of shale alternating with light grey, very thin-bedded, slabby, fine-grained, hard sandstone carrying a few ostracoderm fragments. No other fossils have been found. Because of the softness of these beds, streams following this structure have produced a striking alinement of valleys along the coast north of Cape Hothan. For several miles these valleys reflect the strike of the bedrock.

(c) Rocks of this unit have been observed only to the east of the lineament formed by the above-mentioned shale.

These beds are faunally and lithologically similar to those of unit (a), except that the biostromes are in general thicker and in many places grade into bioherms up to 300 feet in thickness. Graphic measurements indicate a thickness of approximately 4,725 feet for this unit.

(d) Upwards, beds of unit (c) pass gradationally into a series of light brick-red to dusky red, finely laminated, flaggy, fine-grained, calcareous sandstone and calcareous greenish grey siltstone in strata up to 20 feet thick alternating with light to medium dark grey, light olive-grey to olive-grey, fine-grained to lithographic, very thin-bedded, in part laminated, flaggy limestone. Only ostracods have been collected from this unit.

Very good exposures of the graptolitic facies (2) outcrop between Abandon and Disappointment Bays on the northeastern coast of Cornwallis Island. Between Cape Phillips and Disappointment Bay, 5,170 feet of strata were measured and sectioned along the shore, where they are exposed continuously for about 8 miles. Graphic measurements indicate that an additional 500 feet of strata are exposed between Cape Phillips and Abandon Bay. At Disappointment Bay, the section is terminated by normal faulting and nowhere has the upper contact of this facies been observed.

Between Abandon and Disappointment Bays, the rocks may be described as generally light to dark grey, fine-grained to lithographic, very hard, dense, very thin-bedded, in part laminated, flaggy, argillaceous limestone, limestone, and calcareous shale. Bedding planes are commonly marked by shale partings. Typical graptolitic shales are represented in the entire sequence by one stratum 110 feet in thickness.

The Cape Phillips-Disappointment Bay section is phenomenal for the fine preservation of graptolites, the graptolites being generally preserved uncompressed in round, brownish grey to brownish black calcite concretions. Approximately 62 horizons have yielded graptolites. Tentatively 16 species of retiolitids, 40 species of monograptides, 2 species of diversograptids, and a few dendroids have been identified. All but 5 monograptid species are uncompressed and have been freed from their limestone matrix by hydrochloric acid and preserved in glycerine. One concretion may yield several hundred specimens. A partly completed study of this fauna by Thorsteinsson has revealed that correlation with European graptolitic facies may be made with comparative ease, generally zone for zone. An age ranging from upper Llandoverian (Gala-Tarannon) through Wenlockian, Ludlovian, and possibly Downtonian is indicated.

The graptolites are associated principally with nautiloids, radiolarians, and triaxon sponge spicules. Many nautiloids have their camerae filled with solid bitumen. Analysis of certain concretions giving a strong petroliferous odour have given up to 4 gallons of petroleum a ton.

Examination of the graptolite facies on the west part of Cornwallis Island and on "Little Cornwallis" Island reveals that, although the lower strata are predominantly limestone, the upper

and preponderant thickness is represented by shale, bearing only sporadic concretions.

On "Little Cornwallis" Island, incompletely exposed strata indicate that the graptolitic facies extends stratigraphically lower than beds at Disappointment Bay, where the section is terminated by a fault, and that it includes not only lower Llandoverian but Upper Ordovician as well. This is demonstrated by uncompressed Ordovician and Silurian graptolites and a rich Upper Ordovician nautiloid fauna. The chronological and stratigraphic relationships of the graptolitic facies of the Read Bay formation to those of the Allen Bay and Cornwallis formations is as yet not completely understood. Presumably the Allen Bay formation is partly if not entirely the chronological equivalent of lower strata of the graptolitic facies.

The reef facies (3) consists of generally greyish yellow to yellowish grey, very thick-bedded (bedding planes are virtually absent for large stratigraphic intervals), massive, fine- to coarse-grained, porous, rubbly weathering limestone, in part dolomitic.

The exact thickness of this reef has not been determined, but graphic measurement indicates a thickness of at least 1,500 feet for the rocks studied thus far. Study of air photographs of the untraversed region to the west, where the rocks lie in apparent stratigraphic continuity with the shelly and graptolitic facies, indicates that the reef may be considerably thicker than the above estimate.

Fossils are in general poorly preserved and are mostly casts or moulds. Corals, stromatoporoids, and in places crinoidal remains appear to be the principal types.

Devonian

Snowblind Bay Formation

Good exposures of the youngest of the conformable Palaeozoic formations so far delineated on Cornwallis Island are in a broad syncline between Read and Snowblind Bays along the east-central coast. The formation is named for the latter locality. Although the contact of the Snowblind Bay formation with that of the underlying Read Bay formation is not exposed, the covered interval along the north shore of Read Bay is only about 150 feet. There and elsewhere the two formations appear to be conformable and the contact between the two is assumed to be where the first persistent stratum of limestone breccia enters the sequence. The present erosion surface marks the upper limit. Graphic measurements indicate a maximum exposed thickness of 800 feet for this formation.

The lower 300 feet or so of the formation consists of thick-bedded, massive to blocky limestone breccia and conglomerate alternating with light brick-red to dusky red, finely laminated, flaggy, fine-grained, calcareous sandstone and siltstone, and greenish grey siltstone. Thin-bedded, flaggy, light grey limestone strata form a minor constituent. The upper 500 feet or so are composed of thick-bedded, massive to blocky, limestone breccia and conglomerate with dusky red siltstone partings between beds.

Strata of sandstone and siltstone reach a maximum thickness of 30 feet in the lower beds, but average about 5 feet. Strata of limestone breccia and conglomerate are up to 30 feet thick throughout the formation, but average about 15 feet. The latter rock type consists of angular to subrounded and a few rounded pebbles and cobbles of varicoloured limestone and some dolomite embedded in a calcareous matrix. The over-all colour varies from greyish yellow to light brick-red, which is the dominant colour of the fragments.

Numerous fossil fragments of fish, including certain ostracoderm head shields, occur in the basal red beds and light grey limestone. Many of the limestone pebbles and cobbles also contain fossils. The latter fossils, for the most part probably derived from older rocks, are chiefly tabulate corals. The exact age of the Snowblind Bay formation is still somewhat in doubt, but preliminary examination of the fossil fish suggests a Lower Devonian age.

Late Palaeozoic or Mesozoic?

Disappointment Bay Formation

A thin and narrow belt of rocks, in all probability a remnant of a once more extensive covering formation, lies along the upper surface of a north-facing cliff at the eastern entrance to Disappointment Bay, on the northeastern extremity of Cornwallis Island. It is named Disappointment Bay formation. It lies in apparent conformity above the graptolitic facies of the Read Bay formation where observed, but stratigraphic and structural considerations indicate that regionally an angular unconformity exists between the two formations.

The Disappointment Bay formation consists of a basal stratum of porous limestone conglomerate, about 35 feet thick and impregnated with solid bitumen. This conglomerate is succeeded by a transition interval of alternating greyish yellow to greyish green, fine-grained sandstone and shale beds with greyish yellow, flaggy, fine-grained dolomite, succeeded by dolomite only. Approximately 80 feet of this formation is exposed.

At Disappointment Bay, the formation is exposed on the coastal cliff along the west limb of an anticline very near its crest (Figure 2) and along the downthrown side of a northwest-striking, west dipping, normal fault. The formation is itself broken by several minor normal faults with the same attitude. Undoubtedly, this local remnant of a formation, presumably at one time more extensive, has been preserved because that part of the formation has been depressed by faulting. On the east limb of the anticline the formation has not been found. Where the Disappointment Bay formation is exposed on the west limb of the anticline, the basal conglomerate lies a few tens of feet above the lowest Wenlockian graptolite zone of the Read Bay formation. Approximately 3,700 feet east of that locality, on the east limb of the anticline and the upthrown side of the normal fault, the same zone occurs and is followed eastwards and stratigraphically upwards by thousands of feet of the Read Bay formation without any sign of the Disappointment Bay beds, in spite of the fact that the section is virtually continuously exposed for 8 miles along the coast. It seems certain that the Disappointment Bay beds must have been laid unconformably over the folded Read Bay beds; the apparently conformable relations, truly a disconformity at the entrance of Disappointment Bay, must result from the fact that the younger strata were laid down on the gently inclined beds at the eroded crest of a broad, open anticline in the Read Bay formation.

The character of the lithology and the consolidated nature of the beds make correlation of the Disappointment Bay formation with the Intrepid Bay formation highly improbable. The discovery of diagnostic fossils in beds of the Disappointment Bay formation would be a great help in dating the folding of Lower Palaeozoic rocks of Cornwallis Island. For the present the age of this formation can only be guessed as Upper Palaeozoic or Mesozoic.

Cretaceous or Tertiary?

Intrepid Bay Formation

The Intrepid Bay formation is represented by a single outcrop in the southwest of Cornwallis Island, at the head of Intrepid Bay, from which the name is derived. Approximately 2,000 feet of the formation has been preserved along the down-faulted side of a northwest-trending fault. It rests with angular unconformity on beds of Allen Bay formation.

The formation comprises an alternating series of white to light grey sand, clay, and coal seams. Locally, the sand strata are crossbedded and iron stained. The coal seams, at least twelve in number, vary from a few inches to 5 feet in thickness.

No fossils have been found in this formation, but the unconsolidated nature of the sediments, the low grade of the coal (sub-bituminous), and the structure and stratigraphy of the formation are similar to Cretaceous and/or Tertiary sediments in other parts of the archipelago.

QUATERNARY GEOLOGY

Glaciation

There is sufficient evidence to prove that the island was glaciated at least once. Bedrock, striated consistently along the same direction over large local areas, was observed in the vicinity of Resolute Bay and Read Bay, and indicates that ice moved outward from a central location on the plateau. It thus appears that the detected period of glaciation was a local one. This would give support to the opinion of many, and lately of Jenness (1952), that if the Arctic islands north of Barrow Strait and Viscount Melville Sound were covered by ice, they were so covered as the result of local ice accumulation. This leaves unexplained the rock fragments, exotic to the bedrock on which they lie, found in areas exhibiting no evidence of recent submergence.

Striated boulders and cobbles of rocks indigenous to the island occur in widely scattered localities. Morainal hills up to 250 feet high occur near Read Bay and Marshall Peninsula. Terminal moraines several tens of feet in thickness have apparently contributed, by damming streams, to the formation of a series of lakes north of Assistance Bay and of the smaller Laura Lakes. Although bedrock is exposed over much of the uplands, particularly the plateau, the greater part of the island surface is a mantle of clay and rock debris. The mixture is either till or regolith, but it is difficult to differentiate between the two everywhere because the original characteristics have been obliterated in many places by widespread solifluction. Much of the present mantle of the island can only be described as resulting from this subsequent process, the origin of the original material being in doubt.

The east coast of Cornwallis Island is broken by numerous fiords and "U"-shaped valleys in which major streams, flowing at grade for shorter or longer distances, run into Wellington Channel. Sophia, Eleanor, the largest of the Laura Lakes, and several other unnamed finger lakes occupy segments of such valleys and apparently owe their origin to local excavation of the floors of pre-glacial stream channels by seaward advancing ice tongues. Such prominent coastal indentations, as for example Barlow Inlet and Helen Haven, closely resemble fiords; sounding of the former revealed the presence of a topographic high across the mouth, which may be a terminal moraine. Numerous small

cirque-like depressions with rock basin lakes, differentiated with difficulty from nivation hollows, occur along the brim of the sea-coast and plateau facing Wellington Channel. Minor, second cycle streams flow from these "cirques" in "V"-shaped valleys, and, in their early stages of erosion, reach the sea by multiple cascades.

Approximately 12 miles directly west of Read Bay and to the west of a prominent north-trending range of hills, is a group of linear rock basin lakes, perhaps as many as one hundred. The lakes vary from a few feet to a mile in length. They trend northerly along the strike of bedrock and occupy depressions between roches moutonnées. A south to north direction of ice flowage is indicated at this locality.

Erratics are common at all elevations on the island and especially upon the raised beaches, where there is apparently an inverse ratio between their incidence and their height above sea-level. Above the recognizable limit of recent marine submergence on the uplands, the following rock types have been found, in their approximate order of abundance: red quartzite, quartz sericite schist, granite-gneiss. No boulders exceeding 10 inches in diameter have been observed, the average erratic being apparently cobble-size above upper limit of recent marine submergence, whereas erratics weighing over a ton commonly occur on the raised beaches. As the raised beaches are, for the major part at least, post-glacial, there can be little doubt that the boulders on them are not true glacial erratics but have been ice-rafted to their present position. The problem of the erratics on the uplands exotic to the island is a more complex one, which deserves further study.

Marine Beach Deposits and Emerged Strand Lines

Striking topographic features of Cornwallis Island, and indeed along many other coasts of the Arctic, are emerged strand lines. These are best developed and best preserved where the land slopes gently to sea where a series of raised beach ridges and intervening swales rise successively higher above sea-level and, except for local irregularities, parallel the present coast-line. They may be observed sweeping up the major stream valleys, bays, and fiords, and around headlands and points. Their emergence clearly post-dates the development of major streams and the period of glaciation. Second cycle streams, which without exception have smaller valleys than first cycle streams, have cut at right angles across the strand lines; a few have eroded gorges as deep as 100 feet through strand lines and into bedrock, along which they commonly flow through a series of waterfalls and cascades.

The raised beaches are composed of rounded to angular limestone and dolomite pebbles and cobbles. The presence of numerous fossils indicates that this material originated entirely

from local rock formations. Many of the pebbles and cobbles on the surface are solution faceted, whereas those below the surface are rounded to subangular (See Nichols, 1953, p. 273). Numerous lakes, presumably occupying initial irregularities on the pre-beach sea floor, and swale ponds exist on the emerged beaches. The thickness of the beach deposits varies from very thin, with bedrock projecting through, to deposits 30 feet thick, as observed along stream cuts.

No well-defined strand line was observed above an elevation of 275 feet, but the limits of maximum submergence, possibly of the same cycle as the beach deposits, may be determined by other criteria. Three complete walrus skeletons were seen at elevations from 275 to 300 feet above sea-level, two on Cornwallis Island and one on "Little Cornwallis" Island. Marine shells, similar to forms existing today in the Arctic Sea, have been collected on Cornwallis at elevations up to at least 425 feet. Broad, comparatively level areas are common on the uplands adjacent to the coast, at elevations considerably below that of the plateau remnant. These may represent wave-cut benches. One noteworthy example, having an elevation of approximately 400 feet, is between Cape Phillips and Disappointment Bay. Numerous marine shells were observed on its surface.

The prevailing sea current off the east coast of Cornwallis Island is southerly, a fact noted by members of the expeditions led by William Penny and Sir Edward Belcher in the early 1850s. Yet, inlets, bays, and the major stream valleys on that coast have, near their outlets and on their south sides, some large spits extending northward and covered with many successive strand lines. This indicates that the prevailing coastal current was northerly in relatively recent geological time.

The general and recent sequence of events by which the present configuration of Cornwallis Island has evolved may be briefly outlined as follows:

(1) Advanced peneplanation.
(2) Uplift and development of first cycle streams. At this time the approximate present configuration and a relief somewhat greater than at present probably were attained.
(3) Glaciation growth of an ice-cap, probably accompanying, but possibly preceding, submergence.
(4) Emergence, probably closely following deglaciation. The formation of successively lower strand lines and the development of second cycle streams.

There is some evidence of an earlier and greater submergence than that indicated by raised strand lines, but it is masked, to a large extent, by more recent events.

STRUCTURAL GEOLOGY

Cornwallis Island is underlain by an abnormal thickness of predominantly Lower Palaeozoic marine sediments, suggesting geosynclinal deposition. The lithologies and faunae of Ordovician and Silurian strata indicate a deepening of waters to the north and northwest and shallowing and finally land emergence to the south and southeast.

All Lower Palaeozoic rocks on Cornwallis have been deformed into a series of folds trending approximately north by northwest, although local structures may deviate radically from the regional trend. The attitude of beds varies from horizontal to vertical, but low angle dips prevail over large areas. No overturning, except in very local structures, appears to have taken place. The structure of Cornwallis Island is rather unusual in that moderately steep dipping folds are separated by larger areas of gently dipping folds. Fold axes are generally widely separated except on part of "Little Cornwallis" Island mapped where fairly steep dipping folds lie with axes in close parallel juxtaposition.

The dating of the orogenic movement that has taken place on Cornwallis Island and in adjacent areas is as yet unknown (See Fortier and Thorsteinsson, 1953). Neither the Intrepid Bay nor Disappointment Bay formations, which rest with angular unconformity upon the Lower Palaeozoic formations, have yielded fossils. Moreover, present data is insufficient to determine the direction in which the deformative forces acted, but two large asymmetrical structures, the Allen Bay and Cape Hotham anticlines, have west- to southwest-dipping axial planes, which suggests that the deformative forces may have acted towards the east or northeast.

Normal faulting, post-dating deposition of both the Intrepid Bay and Disappointment Bay formations, has affected the island and is directly responsible for the preservation of these formations. With local deviations, the trend of normal faulting parallels the regional strike of the fold axes. These faults, which are as a rule unusually straight over considerable distances, are most readily detected by unusual linear segments in streams or by linear topographic depressions extending indifferently across country and structure; the linears evidently developed from the more readily eroded, shattered rock of the fault zones. The Intrepid Bay fault, along the downthrow side of which the formation of the same name has been preserved, is marked by a prominent fault-line scarp that extends from Intrepid Bay to Stanley Head. The normal fault in the vicinity of Assistance Bay is characterized by a zone of calcite fillings up to 320 feet thick.

Jointing is very persistent in all Lower Palaeozoic rocks. In general one system with two vertical sets prevails. One set generally parallels the strike of strata, the other the direction of dip. Jointing is strongly reflected in the drainage, particularly in smaller tributary streams, to which it imparts a rectangular drainage pattern.

ECONOMIC GEOLOGY

Oil and Gas

Many special factors must be remembered in considering the economic possibilities of Cornwallis Island as a potential source of oil and gas. Although Arctic winter temperatures are in general comparable to western Canada, where exploration for petroleum has proved feasible all year round, the "dark period" and long winters may impose special limitations. Moreover, the season for ship transportation is short and may prove hazardous because of moving ice. These and other problems are beyond the scope of the present report.

For accumulations of oil and gas to exist in an area underlain by a thick series of marine sediments, such as Cornwallis Island, first there must be a source rock and secondly reservoir rocks in suitably disposed structures; the latter may be deformational, depositional, or post-depositional, or a combination of two or more of these processes. Structures such as these have not yet been delineated on Cornwallis Island, but the age and lithology of the rocks and general structural conditions lend much encouragement to further exploration, not only for this region but adjacent areas as well. The numerous discoveries of bituminous residues in favourable reservoir beds, such as the Allen Bay formation and the basal conglomerate of the Disappointment Bay formation, indicate past accumulations of petroleum. The graptolitic facies of the Read Bay formation is considered favourable source beds. The numerous biostromes and bioherms in the shelly facies of the Read Bay formation and the large interfacies reef at Cape DeHaven would possibly constitute both reservoir and source rocks if located at depth in structures of proper closure. The Ordovician-Silurian facies change from north to south across Cornwallis Island is of special interest. A thick sedimentary sequence was evidently deposited in contrasting and most probably changing marine environments. Thus a zone of stratigraphic traps is possibly indicated, not only on Cornwallis Island but in adjacent parts of the archipelago as well.

The rocks outcropping on Cornwallis are entirely unmetamorphosed, and deformation appears to have been mild. Although the orogeny and later normal faulting affecting the island may have destroyed some petroleum bearing structures, it may well have favoured the formation of others.

The following table gives the results of micro oil assays of small samples made by D. S. Montgomery of the Mines Branch:

Oil Content of Rock Specimens

Sample No.	Formation	Oil content (Imperial gallons per ton)
1	Read Bay	4
2	Read Bay	1.5
3	Read Bay	0.4
4	Allen Bay	3.2

Samples Nos. 1 and 2 are dolomite concretions of Late Ordovician age collected on Marshall Peninsula in the graptolitic facies of the Read Bay formation.

Sample No. 3 is a limestone concretion of Silurian age collected between Disappointment Bay and Cape Phillips in the graptolitic facies of the Read Bay formation. Graptolites were previously removed from this sample.

Sample No. 4 is a shaly limestone of Silurian age collected along Shellabear Creek in ostracoderm beds of the Allen Bay formation. All samples had an unusually strong odour of petroleum, or showed "oil stains".

Solid bitumen occurring in the basal conglomerate of the Disappointment Bay formation is native asphalt, according to D. S. Montgomery.

Coal

Coal occurs in the Intrepid Bay formation in southwestern Cornwallis Island. At least twelve sub-bituminous coal seams, ranging in thickness from a few inches to 5 feet, occur interbedded with sand and clay.

W. J. Montgomery, of the Division of Fuels, Mines Branch, obtained the following from the analysis of a single specimen of coal from the Intrepid Bay formation:

Analysis of Coal from Intrepid Bay

	At capacity moisture	As rec'd.	Dry
	Per cent	Per cent	Per cent
Proximate analysis			
Moisture	20.8	7.0	0.0
Ash	4.5	5.3	5.7
Volatile matter ...	40.4	47.4	51.0
Fixed carbon ..... (by difference)	34.3	40.3	43.3
Ultimate analysis			
Carbon	-	-	-
Hydrogen	-	-	-
Sulphur	1.4	1.8	1.9
Nitrogen	-	-	-
Ash	-	-	-
Oxygen (by diff.) ..	-	-	-
Calorific value			
B.T.U./lb. gross	7,950	10,035	10,785

Rank A.S.T.M. - sub-bituminous C.
Moist mineral matter free B.T.U., 8,367

Remarks: The capacity moisture is in all probability on the low side because of the dry state of the sample on which the determinations were made.
Dashes (-) indicate no determination made.

Cornwallis Island Lat 74.36 N Long 94.20 west

(These are to Certify that the Felix Discovery Vessel under the Direction of Captain Sir John Ross, R.N. in search of the Expedition under Captain Sir John Franklin arrived here on the 12th of September 1850, and remained until the 12th of August 1851 in Company with the Lady Franklin and Sophia Brigs, While the Squadron under Capt. H.T. Austin Consisting of the Resolute & Assistance D.S. the Pioneer and Intrepid S.C. were frozen in near to the North of Griffith Island, that Search has been made, between Cape Walker and Banks's Land, between Cornwallis Island and Melville Island and up the Wellington Channel to Lat 76.26 N and Long 102 west but without finding any traces of the missing Ships, since they left Beechey Island in September 1846, where they had wintered.

That the Yacht "Mary", with Provisions is left as a Relief vessel at Cape Spencer and Notices at the Several places the parties visited are left besides at Port Leopold where there is a large Depot

Given under my hand this
12 day of August 1851 — and
Left in a Cairn by

John Ross

Capt Royal Navy in Charge of a private Expedition in Search of the missing Ships under Sir J. Franklin)

Plate I. Facsimile of note by Captain Sir John Ross found in a cairn on Prospect Hill near Assistance Bay.

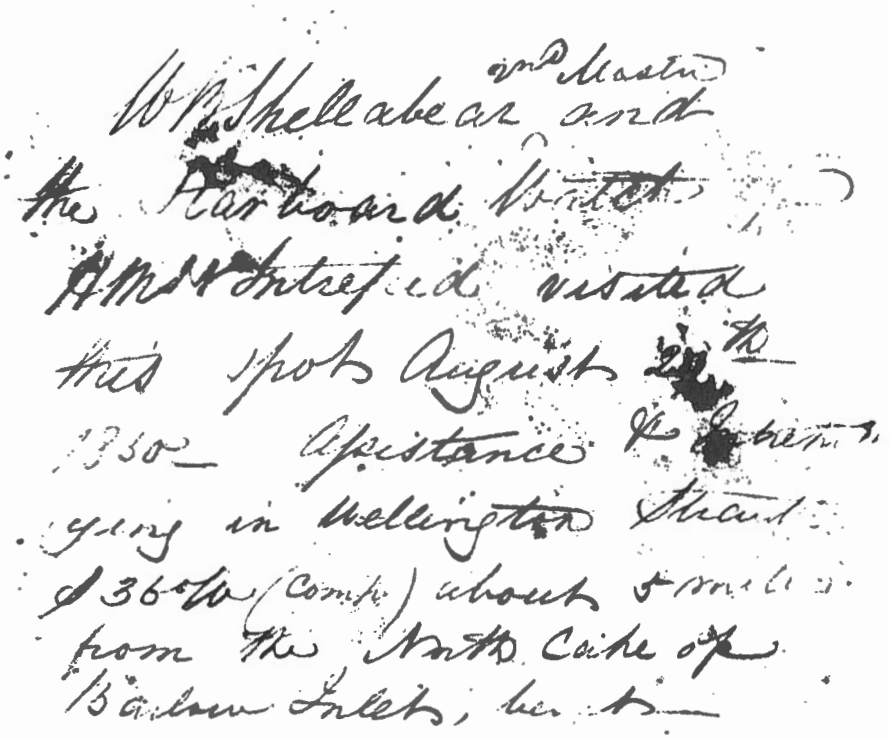

Plate II. Facsimile of note found in bottle in Shellabear stream at the head of Barlow Inlet.

11 Day of May 1851

Left by a searching Party from H. M. Brigs Lady Franklin & Sophia at present lying in N. Lat. 74°40'; W. Long: 94°50'.

Offr. Commdg: party Depots of Provisions, etc at McKenzie Whaler Point; & Cape Hay, on the south shore and at Cape Spencer; and 5 miles W: of Cape Hotham.

Expedition under Capt: Austin at Griffiths Isld. one under Sir John Ross in harbour 12 mls: W: of Cape Hotham along with the above brigs under Captn: Penny.

Captain Pullen with a party of ten men, an officer, and boat on sled passed this point on the afternoon of the 18th May.

North Sta 11th

Capt Pullen encamped here on the morning of the 3rd of August on his return with boat and sled from Cape Beecher off which point he Sir E. Belcher with

Figure 1. Extracts deciphered from poorly preserved notes left in a tin can found on the ground at Decision Point.

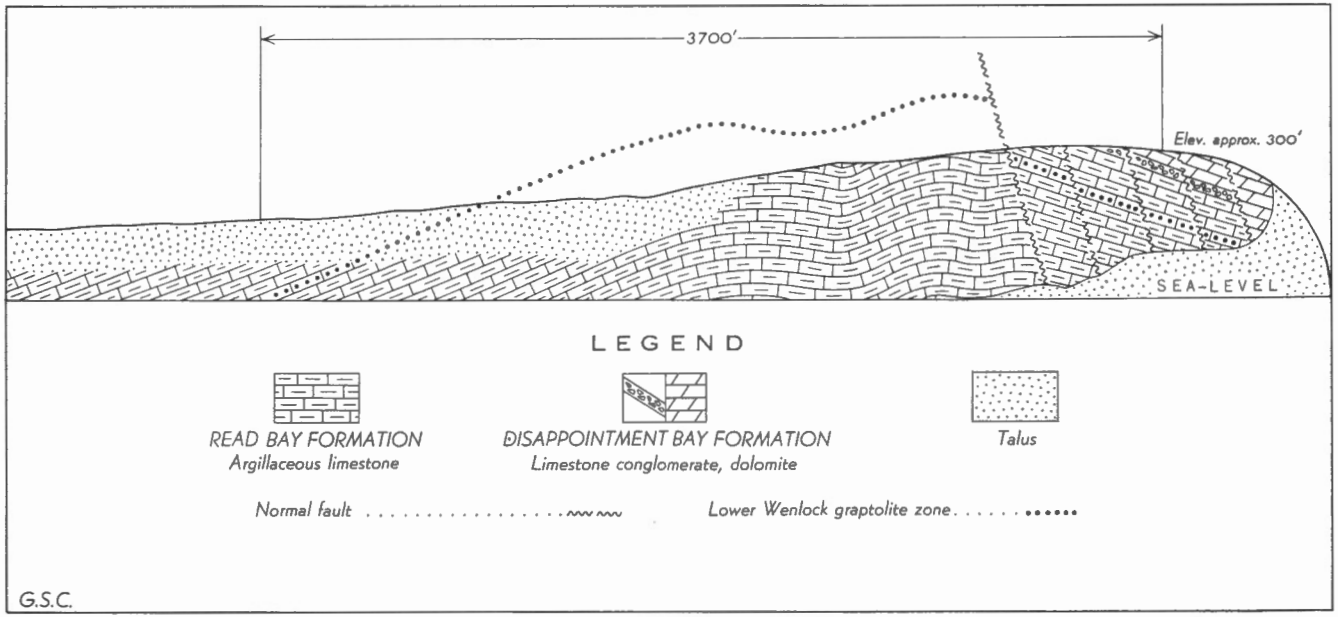

Figure 2. Diagrammatic representation of sea cliffs (looking south) at east entrance to Disappointment Bay, northeast coast of Cornwallis Island showing structural relation of Disappointment Bay formation to graptolite facies of Read Bay formation.