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NOTES ON THE GEOLOGY OF PARTS OF ELLESMERE AND DEVON ISLANDS, NORTHWEST TERRITORIES

(REPORT AND MAP)

By

V. K. Prest

OTTAWA

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INTRODUCTION

During the summer of 1950 the writer was attached to the joint American-Canadian Arctic Resupply Mission as the geological observer, to gather information on the geology of the Arctic islands. The following notes mainly concern the east coast of Ellesmere Island and the south coast of Devon Island, along which the writer observed the geology from shipboard or made brief 3- to 4-hour stops ashore by means of helicopter or small boat. Brief mention is also made of Eureka Sound, Slidre Fiord, on the west coast of Ellesmere Island, and of Graham Island off the southwest coast of Ellesmere, from which places the writer was supplied with samples by the geographical and biological observers. Specimens representative of the bedrock were collected wherever possible, and fossils were collected from bedrock and raised beaches. Shells were also collected from the present-day beach at Thule, Greenland, the most northerly place where they were seen, for comparative purposes. As the time ashore was limited and rigidly fixed when the ships were in transit, there was little opportunity for scouting the better fossiliferous localities, but rather the nearest point at which bedrock could be reached usually served as the collecting ground and observation point. Furthermore, the amount of material that could be collected at any one place was limited to what could be readily carried or conveyed by helicopter on the return passage. The collections are, therefore, fragmentary and possibly none too representative.

The main objective on trips ashore was to gather information on the character and attitude of the bedrock and, where fossiliferous, to gather representative suites at selected or general horizons that might serve to establish the age of the rocks as well as provide scientific data on these northern fossil assemblages. Information was also gathered on the Pleistocene deposits, with special note being made of the raised beaches and their pelecypod content.

From shipboard, attention was given to the attitude and general character of the coastal formations and to the topography. Special note was made of the differences between the topography of parts of the east coast of Ellesmere Island and the opposite coast of Greenland. The features observed suggest quite different Pleistocene conditions, though undoubtedly pre-Pleistocene Physiography is an important factor. Further regional observations are needed.

Air photographs of the east coast of Ellesmere Island were studied to supplement observations on shipboard and provide a map of the shoreline geology from Dobbin Bay north to the Alert weather station at Dumb Bell Bay.

The geological report of the Danish Thule to Ellesmere Island Expedition of 1939-41, by J.C. Troelsen[1], was of great value in following and correlating the general geology.

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[1] Troelsen, J.C.: Contributions to Geology of Northwest Greenland, Ellesmere Island and Axel Heiberg Island; Meddelelser om Grønland, Bd. 149, Nr. 7, 1950.

Fossils collected during the course of the work were turned over to the Division of Stratigraphic Palaeontology of the Geological Survey of Canada, for study and identification. These were for the most part from the early Palaeozoic rocks of the central east coast of Ellesmere Island and some from Dundas Harbour on the south coast of Devon Island. Also included were fragmentary fossils from the Mesozoic formations of Slidre Fiord on the west coast of Ellesmere, together with pieces of lignite and fossil wood. Shells were also submitted from the raised beaches on Ellesmere and Graham Islands and the present-day beach at Thule, Greenland. The fossils collected from the bedrocks add something to our knowledge of the age of the formations and of the faunal record, and the shells from the beaches may serve as a basis for future studies of these features. Air photographs of the extreme southeastern tip of Devon Island, and of parts of the southwestern shore, reveal well-defined raised beaches worthy of study. Cornwallis and adjacent low-lying islands also offer fine opportunities for detailed studies of the beaches and of the life in the seas that formed them.

The accompanying map of the Kane Basin-Robeson Channel part of Ellesmere Island is a much generalized one presented in an endeavour to show some continuity of formations and structures. The Ordovician strata have been identified in Dobbin Bay and Maury Bay. In Dobbin Bay the fossil record indicates Silurian limestones overlying the Ordovician strata. Overlying these limestones are arenaceous 'red beds', which are traceable along a large part of Kennedy Channel, and are, therefore, termed Silurian or younger. They may well be Devonian. The more schistose rocks north of Archer Fiord are not unlike the 'red beds' group, but for the present may best be separated from even the roughly dated formations to the south.

ELLESMERE ISLAND

West Coast of Smith Sound

Only the northernmost part of this coast-line was seen from shipboard and from helicopter. The area is largely ice-capped, but near shore the rocks are exposed, presenting a rugged topography of marked relief. J.C. Troelsen has mapped the bedrock as a group of igneous and metamorphic Precambrian rocks. As seen from helicopter, they are markedly banded rocks, with rolling moderate dips, and are, therefore, part of Troelsen's metamorphic complex, and most probably paragneisses. Troelsen claims that the area west of Smith Sound rises to 1,300 metres (the Prince of Wales Mountains) as distinct from the lower (400-500 m.) modified plateau areas to the south and west, and a narrow belt immediately north of it, including Bache Peninsula.

Eastern End of Bache Peninsula

The eastern end of Bache Peninsula is very precipitous, vertical cliffs of early Palaeozoic rocks, or steep talus slopes, rising directly from the sea, with few erosional indentations. Troelsen reports elevations on the peninsula of 400 to 500 metres. The highest point visited by the writer on Cape Albert, at the east end of the peninsula, was 1,950 feet above sea-level, but a short distance to the southwest it is probably more than 2,000 feet. The upper surface of the peninsula is gently undulating, due in part to glacial modification of the pre-existing stream-channelled plateau. The topographic expression of very small to fair-sized valley glaciers is still evident. Consequent stream channels have further modified the plateau area. The influence of the gently

dipping bedrock structures on the development of the erosional pattern is quite marked. The south coast toward the eastern end of the peninsula is more accessible from the sea, due, apparently, to a low area of Precambrian rocks, but behind these the Palaeozoic rocks again rise abruptly.

The writer was ashore for 3 hours on the upper surface of Cape Albert. The bedrock there, according to Troelsen's report, is Eo-Cambrian in age. The rocks seen along the tops of the cliffs, and occasionally protruding a few inches to a few feet through the thin mantle of drift inland from the cliff edges, were limestones and dolomitic limestones. These have been permeated by siliceous ground waters, and the resulting rock on weathering is a hackly surfaced 'cherty' limestone. The Eo-Cambrian, according to Troelsen, is a non-fossiliferous series of sediments. A few poorly preserved 'fossils' were collected. Study of these gave no convincing evidence that they were organic, but only that two of them were suggestive of corals, one of a worm burrow, and one of a gastropod.

The upper surface of Cape Albert is covered by a thin mantle of drift, which appears to be a mixture of till and some weathered residuum of the limestone content of the till and the bedrock. It is a clay-silt-pebble-rubble mixture, and shows well-developed polygonal structures. The latter in places show three distinct parts — a central clayey (drift) part, a surrounding zone of coarse limestone fragments, and an outer zone of weathered, hackly surfaced, limestone fragments. On sloping surfaces frost-heaving action is more pronounced, and the fine materials are separated from the coarser limestone fragments so that only the latter remains exposed at the surface. Weathering of the limestone fragments gives rise to the hackly surfaced limestone rubble, which is the dominant characteristic of Cape Albert. The limestone fragments average around 10 inches in diameter. On still steeper slopes a more advanced state of weathering of the limestone rubble develops a 'cindery' type of residual cherty limestone, which is largely composed of the former cherty or siliceous pore and fracture fillings.

The drift mantle includes erratics of black shales up to 4 feet in diameter, and sparse, pebble-size, fragments of igneous and metamorphic rocks.

Dobbin Bay, Kane Basin

Several Canadian observers were landed on a small delta on the eastern shore of Dobbin Bay alongside Cape Schott on the night of August 9 and morning of August 10. Little time was spent examining the unconsolidated materials, as information on the bedrock formations was the main objective. The drift deposits represent a large terraced delta with well-developed strand lines at 6, 25, 55, and 82 feet. The 25-foot strand line is largely a wave-cut bench or terrace in the foreset beds of the 55-foot strand line. At the latter level there is a well-developed 5-foot storm-beach and, about 100 yards inland from this beach (possibly at an elevation of 56 feet), a 4-foot storm-beach. At elevation 82 feet, there is an 8-foot storm-beach. Mollusc shells were observed at several places in the deltaic materials. The most shell-rich material, however, was found at an elevation of 102 feet, where a short-lived sea-level lapped into a small, cirque-like feature. Glacial debris was probably sluffing and sliding into the sea in which the molluscs lived, and they became trapped in the till. Present day, wet-season wash and slumping are exposing the shells

in the till materials. Mollusc shells were also found in great abundance below the low-tide flats in a small tide-water rill. A few shells seen along the shore might represent recent additions, but some are no doubt washed out of the upper materials. Neither molluscs themselves nor any indication of their presence were seen over many square yards of near tide-level mud-flats, and none was collected during the bottom-dragging tows carried out by the biological investigators along the shorelines at both high- and low-tide periods. It appears, therefore, that the sea levels have risen slightly in very recent time and that the water has become colder and less habitable for molluscs.

Numerous shells were collected from the till-like materials at an elevation of 102 feet, and a few similar forms were obtained from the raised beach gravels. Those identified included:

Astarte n.sp?

Saxicava arctica (Linné)

Mya truncata Linné

Macoma calcarea (Gmelin)

Also found on one of the beaches is the barnacle Balanus balanus.

From a 2-foot or more shell-rich gravel layer exposed in a small rill at low-tide level below the present-day mud-covered flats only Saxicava arctica and Mya truncata were collected. These were noticeably thicker shelled than the same species from the higher levels. All the shells contrast sharply with the same present-day Atlantic species, and with those of the Champlain Sea deposits of the Ottawa-Montreal-Quebec area, in that they are generally larger and heavier shelled.

J.C. Troelsen did not visit or obtain information from this part of Dobbin Bay, but he indicated rocks of probable Silurian age immediately across the bay, to where the rock structures were observed to be continuous. The rocks are moderately folded. They appear to trend in a north-northeast direction and generally dip northwestward, but anticlinal and synclinal folds are present. From the delta eastward toward Cape Hawkes there is a change from the gently westward dipping rocks to tightly folded rocks. Washington Irving Island, however, though it lies close to Cape Hawkes, is composed of gently undulating strata. These are light-coloured rocks of general buff and grey-buff tones, similar to those exposed on either side of the delta area, and again across the bay on the northeasternmost point. Lying above, and hence west of, the massively bedded buff and grey limestones are some strikingly banded red and grey formations. These could be seen a short distance up the valley above the delta but could not be reached on foot. The stream-channel boulders, however, reveal these rocks to be largely red sandstones and pebble conglomerates. They are interbedded with grey and whitish sandstones as well as non-fossiliferous grey limestone including edgewise conglomerate members.

The rocks that were directly observable along and above the banks of the small stream, which at its lower end is now well trenched in the terraced delta, were seen to be fine-textured, fossiliferous grey limestones, occurring as very thick beds. The large bluff immediately west of the delta and also forming the cliff-face between this point and eastward to near the island appears to be composed entirely of these massively bedded grey limestones. Parts

of this formation were examined along the creek above the terraced delta. Fossils were collected from the bedrock at known elevations and positions on the creek, and also from the talus slopes, as a means of gleaning some data on the fossil content of the overlying and otherwise inaccessible horizons. The fossils observed appear to include both Ordovician and Silurian forms (corals, brachiopods, trilobites, cephalopods, gastropods, crinoids, ostracods, and bryozoa were noted), but the formation appears to be Ordovician in large part. If both periods are represented, as indicated by the presence of Silurian fossils on the talus slopes, they would appear to be in conformable contact, as no 'break' could be seen in the limestone cliffs. If any unconformity or disconformity occurs in the section of these rocks it might be expected at the contact between the massive grey to buff limestones and the overlying banded red, white, and greyish conglomerate, sandstone, and limestone formation.

The nearest rocks mapped by Troelsen to the south of Dobbin Bay are the Ordovician rocks on Norman Lockyer Island and on the mainland to the west, which points lie some 22 miles to the southwest of Cape Hawkes (See Map). The Dobbin Bay formations referred to above, lie, therefore, between his definite Ordovician and probable Silurian. In neither place does he record red sandstone and pebble conglomerate, though these red beds are to be seen in his probable Silurian on the north side of Dobbin Bay. Possibly Troelsen, or an earlier investigator, visited the outer point where the limestones alone are present. The rocks around the entrance to Dobbin Bay have been mentioned as representing the Ordovician, Silurian, and possibly even Devonian Systems, but for the most part have been regarded as largely Upper Silurian (Etheridge: Summary of British Expedition under Sir George Nares, 1878). The present work indicates they are Upper Ordovician (Richmond) overlain by Silurian beds.

The first bedrock observed along the small stream that cuts through the delta was about ½ mile inland at an elevation of 130 feet. This is a fossiliferous grey limestone, but the only fossils readily obtainable were from loose pieces of limestone in the creek bed believed to be from the immediately adjacent bedrock.

The following fossils were identified:

Calapoecia canadensis ungava Cox

Strophomena sp.

Dinorthis sp. close to D. carleyi insolens Foerste

Lophospira sp.

At an elevation of 180 feet, at the foot of a 20- to 25-foot waterfall, the limestone is highly fossiliferous. A study of both fossil specimens and coquina resulted in the following identifications:

Palaeofavosites asper (d'Orbigny)

Calapoecia canadensis Billings

Maclurina manitobensis Whiteaves

Ceraurus sp.

also a Pterygometopinae and other trilobite fragments, brachiopod fragments, crinoid disks, bryozoa, and an ostracod. All the above

are indicative of an Upper Ordovician (Richmond) age.

Above the waterfall, a talus slope rises to the foot of a sheer cliff at an elevation of 300 feet. The cliff rises some 500 feet above the talus. The limestones on the talus are fossiliferous. Specimens were collected from this talus as representative of beds exposed at higher horizons on the cliff face. The following Ordovician (Richmond) fauna was recognized:

Streptelasma sp.

Calapoecia canadensis Billings

Calapoecia arctica Troedsson

Sowerbyella sp. (fragment)

Strophomena cf. lenta Troedsson

Trochonema umbilicatum Hall (large variety)

cf. Vogdesia sp. (fragment)

Halysites (Arcturia) sp.

Indicative of Silurian rocks somewhere on the cliff face were:

Halysites microporus Whitfield

Halysites cf. harti Etheridge

Favosites gothlandicus (Fought)

Also identified from the south shore cliff face east of the delta is the Ordovician fossil Gonioceras cf. groenlandicum Troedsson.

Maury Bay, Kane Basin

In the vicinity of Maury Bay, Troelsen has indicated both Ordovician and Silurian rocks, with contacts trending northwest, though the trends of the folds appear to lie at right angles to this direction. From shipboard and from helicopter, the rocks south of Maury Bay along the coast were seen, when viewed from the east, to be gently folded and generally dipping northward or flat-lying. They also appeared to be flat-lying when viewed from the south, but drift or talus in the valley largely obscured the bedding. A short distance inland from the shoreline rocks, the uppermost parts of some of the hills are composed of a massively bedded grey limestone, which appeared to be more flat-lying in a north-south direction than the underlying more thinly bedded sea-coast limestones, and to have an appreciable dip to the west. There is, therefore, a possibility of an unconformity in this area, but the difference may be due entirely to the variable folding of the strata.

The bedrocks observed on a 3-hour trip ashore in Maury Bay were fossiliferous limestones and dolomitic limestones. These were studied in the first small creek valley entering the south side of the main valley about half a mile inland. Here the rocks strike northeasterly and dip 20 degrees to the north-northwest. They appear, therefore, to conform with the upper, massive, west-dipping formations viewed to the south of Maury Bay. All the rocks in Maury

Bay have this westward dip.

A fossil collection was made from bedrock between 270 and 540 feet above sea-level. Most of the fossils were collected from a grey, fine-textured, dolomitic limestone member exposed at 270 to 280 feet and from a more platy-bedded and much fractured limestone up to 320 feet. The fossil 'sponge' Receptaculites was much in evidence in the lower part of this thinly bedded limestone, and indicates an Ordovician age. Above the small waterfall at 320 feet, the rocks are more massive, fine-grained, grey limestones, with sparse fossils (Halysites, a Streptelasma-like coral, and a low-coiled gastropod). In the neighbourhood of the second small waterfall, at an elevation of 540 feet, the limestone was again dolomitic. Corals, 'sponges', and crinoid stems were observed.

The complete fossil assemblage indicative of Ordovician (Richmond) age is as follows:

Maclurina manitobensis Whiteaves

Liospira sp. nr. L. americana (Billings)

Receptaculites arcticus Etheridge

Calapoecia canadensis cf. var. anticostiensis Billings

Plectorthis plicatella Hall var.

Plasmopora lambi Schuchert

Streptelasma sp. or Zaphrentis sp.

Halysites sp.

Maclurites acutus Parks

The banded, red formations observed at Dobbin Bay should occur to the west of these Maury Bay limestones, but were not observed. The possible unconformity near Maury Bay must be between Ordovician and older strata.

Time did not permit a study of the unconsolidated deposits. The main part of the valley consists of stream-terraced outwash, which grades upward into kame-terrace materials and then talus. No beach deposits were seen, but detailed observations might reveal their presence. A small delta is being formed in Maury Bay.

Kennedy Channel

The sole point visited along this lengthy and little examined coast-line was in the first bay to the south of Carl Ritter Bay at latitude 80°47', longitude 67°35'. There the writer was landed by helicopter, for a brief period, in a large outwash-filled valley with a deltaic terminal. The present-day braided stream channel is cutting through former delta deposits at its lower end, which represent periods of higher sea-levels, and two distinct stream terraces are recognizable on the north side of the valley. Also, on the north side of the valley and extending back about ¼ mile from the sea, there is an irregular ridge of gravels rising 30 to 50 feet above the bordering gravels. This appears to represent an esker or crevasse-filling deposit. It merges westward into a

gravelly surfaced deposit, which may represent a modified kame terrace or morainic material. Rising above this area of gravelly materials are the steep talus slopes and the bedrock cliffs. No time was available to scale the talus and inspect the bedrock, but several huge blocks at the foot of the talus were examined as representative of some higher bedrock horizon. These were found to be a streaky-banded, white and grey, cavernous, crystalline limestone (dolomite). The bedrocks visible from the foot of the talus slope appeared to be horizontal. Study of an air photograph indicates an unconformity at this locality, finely banded, west-dipping upper strata overlying what appear to be flat-lying lower formations. It, therefore, seems probable that Palaeozoic rocks overlie Precambrian rocks at this locality. Further work should be done along this valley. A careful perusal of the gravels of the stream terraces and the ridge gravels did not reveal the presence of any fossils, but rather the presence of much igneous and metamorphic material, and some black limestone. No such rocks were evident in the surrounding cliffs, and thus they may well represent rocks to be found farther up the valley. The main valley may represent a large fault.

The rock structures along most of the length of Kennedy Channel were observed from shipboard, in part on the trip north and in part on the return trip. Inaccuracies of the maps available at the time, and the irregular course of the ship due to ice conditions and some fog, made location and correlation of the shorelines and the bedrock formations most difficult. A strikingly banded, red, black, grey, and buff formation served as a very useful horizon marker along extensive stretches of the coast-line. The red conglomerate and sandstone, and some of the limestone, as seen in Dobbin Bay appear to be part of this series.

Immediately north of Maury Bay, the formations along the sea-coast have an apparent dip of 35 or 40 degrees north. Farther north, the cliff west from Cape Norton Shaw reveals a dip of 25 or 30 degrees, while in the bay and on Cape McClintock at the northeast end of the bay the dip is only 20 degrees north. As the true dip is probably toward the north-northwest (as determined in Maury Bay) the observed dips along the north-south trending coast-line cliffs largely reflect the true dips of the folded structures, here more inclined than in Maury Bay. The dips as seen along the north shore of Scoresby Inlet, however, reflect the plunge of the folds, as air photos reveal the strike of the strata to be more or less parallel this shoreline.

Northward, between Joiner Bay and John Richardson Bay, there is a low-lying and seemingly horizontal formation along the coast, composed of very thick dark grey beds. The red, banded formations may be seen inland from the massive grey beds, but the relations of the two formations could not be ascertained. Air photographs of the elongate east-west trending John Richardson Bay reveal plunging fold structures paralleling the bay. A canoe-shaped fold is exposed in the bay in a low-lying formation. This bay should be visited in the future to learn more of the fold structures, possible unconformable relations, and age of the formations.

On Cape Wilkes, at the northeast end of John Richardson Bay, shipboard observations give some indication of an unconformity over half-way up the cliff side. Here the lower beds have an apparent dip of 10 to 15 degrees toward the west, whereas upper horizons appear flat-lying. Along the east side of Cape Wilkes and northward to Cape Joseph Good, the apparent dip is 5 to 10 degrees south. These rocks are banded grey and buff, and probably largely limestones. The beds

vary greatly in thickness; some have a slight pinkish cast. Along the northern side of Cape Joseph Good, distinctly reddish rocks form the cliff top, overlying the grey and buff formation.

On the north side of Rawlings Bay, there are abrupt cliffs of strikingly banded black, grey, buff, and red beds, exposed as the west limb of an anticline with dips changing from 10° to 40° going up the bay. Northeastward toward Cape Lawrence the strata along the shore appear to be flat-lying. This same markedly banded formation of varying thicknesses of grey, buff, and red rocks continues to strike northward along the coast to latitude 80°45', the beds dipping westward at 20 to 45 degrees and having a nearly horizontal attitude along the coastal cliffs. In the vicinity of latitude 80°45' the red beds seem to disappear up a small valley behind a shorline projection of grey and buff banded beds and are no longer discernible farther inland, possibly solely because of the heavy talus on the more gentle slopes in this area. To the north of a bay at latitude 80°47' (the bay visited for a brief period) the banded red, grey, and buff formations are no longer in evidence, their strike apparently carrying them to the east of the coast-line. Possibly, too, their disappearance is in part due to the presumed east-west trending fault down the valley at this locality, as already referred to above, or to the major north-south trending fault along the coast, but in any case the well-banded strata in this bay are believed to be of the same age as the red beds.

The attitude of the rocks on Cape Leopold Von Buch and around Carl Ritter Bay was not recorded. Immediately north of Carl Ritter Bay, however, thinly bedded formations continue to strike along the coast and are seen to be very gently rolling or plunging in attitude. These rocks continue northward beyond Cape Back, plunging gently both north and south.

About midway between Cape Back and Cape Defosse there is an abrupt change in the trend of the coast-line from northeast to north-northeast. Four conspicuous deltas are present along this part of the coast. A large coastal area of banded black rocks, together with much black talus lies immediately south of the most southerly of these deltas and extends south to an easterly trending creek. These rocks stand out in sharp contrast with the buff-toned rocks to the south of the creek along the coast and with a thin 'sliver' of buff rocks extending a short distance up the coast immediately north of the creek. The black rocks also stand out in sharp contrast with well-banded, light-coloured rocks to the west, across a north-south trending narrow valley, as seen on air photographs. The talus from these banded rocks, as seen immediately south of the first delta, is buff coloured. It is not known whether folding or faulting accounts for the abrupt appearance of this distinctive area of black rocks, but it is most probably due to faulting. Immediately north of the first delta, the banded rocks were seen to dip westward at about 20 degrees along the creek valley and at about 5 degrees northward along the sea cliffs. These rocks are again well-banded light and dark grey, buff, and reddish. As far north as the third delta the rocks still appear to strike nearly parallel with the coast and to have a true dip to the west of about 20 degrees. The fourth delta is couched in the bay immediately south of Cape Defosse.

Along the coast-line from Cape Defosse to Cape Lieber the air-photograph coverage was very poor, and the existing maps were at variance as to coastal outlines and even position relative to the Greenland shore. As a result, the observations made from ship-board were not positively related to the air-photographs and the maps. From Cape Defosse northward to a large creek south of Cape Craycroft, the photographs reveal the formations trending northeasterly

parallel with the coast-line. From shipboard, these were seen to be very gently undulating. In the vicinity of the creek the formations swing a little to the east and intersect the coast-line at about 20 degrees. Immediately north of what was believed to be Cape Craycroft, the coast trends more northerly, so the formations there will be intersected at much greater angles, and still farther north, near Cape Lieber, the trend lines intersect the coast at nearly right angles.

From shipboard, the rocks between Cape Craycroft and the creek to the south were seen to be much folded. The beds are generally flat-lying or dip northward at low angles, but locally are nearly vertical, or even overturned, due to numerous drag-folds and some thrust faults. The axial planes of these drag-folds and faults dip northward at 25 degrees. The formations consist of thinly banded, buff, grey, and whitish sediments. Midway between the creek and Cape Craycroft there were numerous thin black beds, which may be either coal or, more probably, shale. On the cape itself, the formation has a general northward dip of 25 degrees. As the ship's course was eastward from Cape Craycroft, a proper view of the rocks northward toward Cape Lieber was not obtained, but they were seen to be folded, with dips generally northward.

Viewed broadly, the area from Dobbin Bay northward to Judge Daly Promontory, in the vicinity of Carl Ritter Bay, is one of rugged, almost alpine-type relief. According to Troelsen, the land to the west (Grinnell Land) is largely ice covered, and rises to heights of about 2,000 metres (Victoria and Albert Mountains). The cliffs along the coast-line are usually around 1,000 feet in height, but a short distance inland elevations up to 6,400 feet have been recorded; yet this area is relatively free of permanent ice-fields. A study of the air photgraphs clearly indicates that valley glaciers formerly occupied all the major eastward-trending valleys. Evidence of this glaciation was also seen from shipboard and in some of the valleys themselves, but no conclusive evidence of major ice movements along the coast was seen. This part of Ellesmere Island would appear to have been a high, rugged area that was covered by a mountain ice-sheet, and later rapidly deglaciated to give some of the aspects of an alpine terrain, with its significant frost-sharpened features. Judge Daly Promontory itself, from Carl Ritter Bay northward, is an area of more gently undulating surfaces, with maximum elevations in the neighbourhood of 3,000 feet. Troelsen regards this section as a former plateau.

In sharp contrast with the rugged topographic features of the southern part of the Kennedy Channel coast of Ellesmere Island, is the opposing and nearby Greenland shore, which is also relatively free of ice. Maximum recorded elevations at the northern end of the channel are only around 3,000 feet, and elevations lessen going southward to around 2,000 feet. The shoreline rocks themselves rise precipitously to more than 1,000 feet around Bessels Fiord on the north to less than 500 feet approaching Kane Basin. Glacial debris was observed perched along the top of the sea cliffs. The sea cliffs along the northern part of the channel and the major fiord walls in this area, show pronounced evidence of glacial scour and U-shaping. Joe Island at the northeastern end of Kennedy Channel and immediately south of the mouth of a major fiord is markedly scoured by ice along its northern and western sides. The fiord trends indicate a northerly ice movement in this area, but the scouring of Joe Island does not appear in keeping with such movements. The exposed coastal area east of Kennedy Channel appears to be a relatively smooth-topped plateau, which has been modified to some degree by glaciation. Post-glacial erosion has developed seashore talus slopes and has cut minor valleys or gulches into the sea cliffs.

As the land now to be seen on either side of Kennedy Channel was formerly glaciated and is now deglaciated to about the same areal extent, it appears most probable that the varying physiographic features reflect different preglacial conditions. In the one case, a mountainous terrain was glaciated, and in the other a plateau. From what little is known of the geology, this difference appears to be intimately connected with the fold structures. The Ellesmere Island rocks were probably gently folded and dissected in pre-Glacial times to yield a mountainous terrain, whereas the Greenland rocks, being more gently undulating, gave rise to a plateau. Pleistocene glaciation and deglaciation has further accentuated these differences. It is possible that the Greenland plateau area was connected with the Judge Daly Promontory plateau, though here the rocks are folded to the same degree as in the rugged area to the south.

Wrangle Bay
(Latitude 82°; longitude 62°30')

From shipboard the rocks forming the cliffs to the south of the entrance to Wrangle Bay appear to be interbedded, buff-coloured limestones or sandstones and dark grey to blackish shales. The former beds are six to eight times as thick as the latter. The formations are gently rolling from flat-lying to 10 degrees north. Immediately north of Wrangle Bay the rocks appear flat-lying along the coast.

Small Bay North of Lincoln Bay
(Latitude 82°15'; longitude 61°40')

Three hours were spent ashore here on August 5. A small valley glacier formerly occupied the present creek valley, depositing much morainic material (a boulder-clay till) along its sides and at its mouth. Alluvial material may also have been deposited in the form of a delta. The sea has worked over the bay-mouth materials and formed a series of beaches at elevations of 30 to 70 feet above present sea-level (precise elevations of the beaches were not possible with the aneroid barometer available). The present-day small stream has trenched deeply into the lateral moraines lining the valley walls and into the beach materials. The moraines merge upward into talus slopes. At the eastern end of the valley, on the north side of the creek, the moraine has been worked over at a former high sea-level, and a distinct marine terrace with a boulder pavement extends back from above the creek to the foot of the talus slope. This terrace is at an elevation of 250 feet. Near its western terminus, a wet-season rill and slumping have exposed pelecypod shells in morainic-type materials at an elevation of 200 feet, which no doubt represents the life of this period of high sea-level. No shells whatsoever were seen along the present-day sea-coast with its ice-choked waters. Medial moraines of very short length, but up to 30 feet high and 50 feet wide at their lower ends, were observed between the position of the marine terrace and the lower creek valley. Glacial ice must have accumulated over the present site of the terrace and then moved down to lower levels toward its western end as two or more small lobes or hanging glaciers. A little bedrock is exposed along the walls of the creek, but the rocks are best studied at higher elevations above the talus slopes. Careful examination of the creek and moraine boulders, talus materials, and bedrock failed to reveal any fossils. The bedrocks are interbedded arkose, greywacke, sandstone, and grey slates, which are only moderately metamorphosed. The bedding is usually masked by the schistosity along which the rocks readily break. Ripple-marked strata are common, including

some very widely spaced ripples. Crossbedding was noted, and the whole formation suggests alternating terrestrial and near-shore depositional conditions.

Above the western end of the marine terrace on the top of the cliff at an elevation of 700 feet, the schistosity was found to have a strike of north 75 to 80 degrees east, and a dip to the southeast of 75 degrees to near vertical. The bedding was observed to dip westward at about 50 degrees, but the true strike and dip were not determinable. From the helicopter, both bedding and cleavage were clearly discerned in the low-lying formations along the seashore immediately north of the creek mouth, and these give the clue necessary to the proper interpretation of the structures to be seen on the air photographs. The rocks are evidently tightly folded into a series of plunging anticlines and synclines trending northerly. The cliff to the north of the creek mouth is about 1,000 feet high, and higher peaks nearby are probably 1,200 to 1,500 feet in elevation.

Small quartz-carbonate veins were seen 'in place', and large pieces of similar yellowish 'float' were frequently observed, indicating vein widths of at least 2 feet. No other minerals were seen in this vein matter.

Air photographs of the general area show it to have a gently undulating surface representing a glacially modified plateau.

Alert Weather Station, Dumb Bell Bay

(Latitude, 82°30'; longitude, 62°10')

The writer did not visit Alert, but a box of nine rock specimens collected by a weather station operator was forwarded to him. These represent both boulders and bedrock found close to the station. Scattered irregularly over the drift-covered surface of the area there are, apparently, numerous erratics up to 3 feet in diameter. These erratics include a peculiar, dark-speckled, sugary-textured sandstone, coarse feldspathic grit, jasperoidal pebble-conglomerate, and less common dark, dull grey limestone. Cobbles, 2 to 3 inches in diameter, of fresh-looking red granite are reported to comprise about one out of every five hundred pebbles and boulders. Future work may reveal the source of these characteristic rocks, and thereby indicate the trend of glaciation in this remote region.

The bedrock around Alert appears to be interbedded, soft, grey shales and fine-grained micaceous greywacke. The shales have slickensided slip planes.

The terrain at Alert is lower and not as rugged as along the east coast of Ellesmere Island, but is a part of the same plateau. It is noteworthy that this large plateau area extending southward to Lady Franklin Bay and westward to Lake Hazen, unlike those already mentioned, is developed in an area of highly folded rocks.

Eureka Weather Station, Slidre Fiord, West Coast Ellesmere Island

(Latitude 80°00'; longitude 86°00')

The writer was also unable to visit this locality. The geographical observer (H. E. Smith) collected a few pieces of bedrock, and some pelecypod shells from raised beach materials, which he turned over to the writer on his return. Smith also obtained some specimens from weather station personnel, which were

picked up to the north of the airstrip along a small creek. These consisted of pieces of lignite, petrified wood, calcite and selenite concretions, and belemnite and gastropod fragments. These fragments were non-determinable, but the belemnites appear to indicate an early Lower Cretaceous age. The fossil wood can only be identified as coniferous.

According to Troelsen's map of Ellesmere Island, the formations around Slidre Fiord are probably Mesozoic (Triassic and Lower Jurassic?), and consist mostly of sandstone and shale with some coal and marine limestone. Two pieces of the bedrock examined were a black shale and a very fine-grained, buff-coloured limestone. According to Smith, the latter occurs as thin beds in the predominant black shale, and is exposed along an east-west stretch of a small creek a short distance north of the weather station. At this locality they are cut by a 7-foot ashy grey-coloured dyke striking east. A thin section of this peculiar dyke showed it to be very highly carbonatized rock, possibly a trachyte. The black shales contain abundant calcite concretions, some of them remarkably well crystallized (dog-tooth spar). Concretions of selenite are also abundant.

Along the east side of a small south-trending creek some distance east of the weather station and of the airstrip, a ridge rises to a height of 2,800 feet. The bedrock capping on this ridge is a diabase, a specimen of this rock having been collected by the biologist, A. Laurie. The underlying rocks have not been examined. The diabase is largely composed of fresh augite and labradorite. Other constituents include a little magnetite and secondary biotite and chlorite.

Pelecypod shells were collected by H.E. Smith from the 75- and 200-foot levels plus fragments from about 250 feet above sea-level, all to the south of the airstrip. These were identified as Astarte borealis Schumacker.

Eureka would appear to be an interesting place for future geological investigations. The climate there is less severe than along the east coast of the island.

GRAHAM ISLAND, NORWEGIAN BAY
(Latitude 77°20'; longitude 90°30')

Shells collected from raised beaches on this island, mostly at an elevation of 75 feet, were identified as Astarte borealis Schumacker, Saxicava arctica (Linne), and Mya sp.

THULE, GREENLAND
(Latitude 76°30'; longitude 69°)

Shells were collected from the present-day beaches at Thulé for comparative purposes. This was the most northerly point visited where pelecypods were noted on the present-day beaches.

Those identified are:

Astarte borealis Schumacker

Saxicava arctica (Linné)

Mya truncata Linné

Macoma calcarea (Gmelin)

Modiolaria cf. M.corrugata (Stimpson)

DEVON ISLAND

Dundas Harbour

(Latitude 74°35'; longitude 82°30')

Four hours were spent examining the rocks on the west side of Dundas harbour. The outer part of the west side of this harbour is lined by steep talus slopes and vertical cliff faces, the cliff top elevation being in the neighbourhood of 1,500 feet. The cliff faces show two unconformable formations, Precambrian gneisses overlain by flat-lying Palaeozoic rocks. The Precambrian gneisses are well banded and have an apparent dip of 10 degrees north. North of the cliff-lined outer part of the west side of the harbour, there is a lower lying area of the Precambrian rocks. There the bedrock is seen to be largely paragneiss, but some of the darker bands, with about 30 per cent ferromagnesian minerals, could represent altered volcanic or dyke materials. Specimens of the various gneisses were collected for reference purposes. All the rocks appear to be much granitized, and some bands are true igneous gneisses. The bands vary from a few inches to some tens of feet in thickness, and are strongly gneissic. Most of the rock weathers pinkish or buff, but some bands are grey or even dark green. The gneissose bands in general strike north 80 degrees west and dip northerly at about 23 degrees, but some evidence of folding was observed. The rocks are probably of Archaean age.

The actual contact of the Precambrian gneisses and overlying Palaeozoic rocks was not seen except from a distance along the cliff faces. There the light greyish Palaeozoic rocks in places appear to lie on reddish rock of variable thickness, which passes downward into dark greyish green rock, but elsewhere they rest on the more characteristic pink or buff weathering gneisses. Inland from the shore, the near-contact was seen in a few places. Up the southernmost small creek valley, in the inner harbour, at an elevation of 785 feet, only a foot or so of drift obscures the contact of the two formations. There the lowest observed Palaeozoic rock is a very thin bed of red sandstone resting on only slightly reddened gneisses, which pass rapidly downward into the banded pink and buff gneiss. In the valley of the second small creek, the uppermost Precambrian gneisses are more basic, greenish types and, at one place, at an elevation of 665 feet, are weathered reddish to a depth of 15 feet. The difference in elevation of the Precambrian-Palaeozoic contact appears to be largely due to a northward tilt of the Precambrian surface, but gentle undulations of this surface are probably also a factor. The more basic bands of the gneiss complex weather red to a depth of about 50 feet, as seen along the outer harbour cliff, but the other members are little affected. Such weathered gneiss materials have probably supplied the red sands that form the thin basal sandstone members of the Palaeozoic formation seen in the first small creek valley, and possibly more prevalent elsewhere.

Aside from the thin, basal red sandstone seen in one place, the Palaeozoic formation consists largely of limestone, sandy limestone, limy sandstones, and minor limestone-conglomerate and edgewise conglomerate members. Ripple-marked horizons are fairly numerous, and rain-printed and crossbedded strata were also noted. Fossils appear to be very scarce. Aside from two small and poorly preserved brachiopods, found in the talus and coming from a small bluff up the first creek valley at an elevation of about 950 feet, the only evidence of past 'life' was possible algal or worm-burrow remains.

A large block of limestone, found by an Eskimo just north of the R.C.M.P. post on the east side of the harbour, contained large coiled fossils, but they are poorly preserved, and the age of the limestone is, therefore, very uncertain. They have been variously reported as of Cambrian, Ordovician, and Silurian age, but the work of Kurtz, McNair and Wales[1] indicates the age as Cambrian and Ordovician.

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[1] Kurtz, V.E., McNair, A.H., and Wales, D.B.: Stratigraphy of the Dundas Harbour Area, Devon Island, Arctic Archipelago; Abstract, G.S.A. Bull., vol. 61, No. 12, pt. 2, Dec. 1950.

Examination of part of the specimen picked up by the Eskimo revealed crinoid stems, brachiopod fragments, a gastropod (possibly Liospira) and probably Maclurites or Maclurina, indicative of an Ordovician age.

Two raised beaches are evident on the west side of Dundas Harbour just north of the cut-back in the sea cliffs, which thereby exposes the area of lower lying Precambrian rocks. One of these beaches merges directly into the present-day beach materials at an elevation of 5 to 8 feet. The other occupies higher ground and has an elevation of 15 feet. Both are characterized by the pinkish colour of the largely gneissic materials in contrast with the present-day mixed grey limestone and gneissic pebbles. There is another poorly preserved beach at an elevation of 85 feet. Other terraces above this appear to be kame terraces, as next the cliffs to the south they show a distinct slope of 2 or 3 degrees to the southeast. These terraces are at elevations of 85 to 90 feet and 135 to 140 feet.

South Coast Devon Island

The sea-cliff formations along the south shore of Devon Island from Radstock Bay to Croker Bay are generally flat-lying or dip gently to the east and west. Towards the western part of the island, in the vicinity of Maxwell Bay, the rocks have a slight westward dip; around Blanley Bay and Hobhouse Inlet, they are flat-lying, whereas farther east, toward Powell Inlet, they have a noticeable eastward dip. Along the east side of Stratton Inlet, the rocks could be seen to have a northward dip. A northward dip and gentle folds are also observable on air photographs of the east side of Burnett Inlet. The formations, therefore, appear to be gently domed. The rocks are generally buff to greyish, but include occasional darker beds and slightly pinkish beds.

The highest part of the south shore seems to be from Graham Harbour to Hobhouse Bay, where the hills are ice-capped and the odd tongue of ice or hanging glacier comes down to the sea. The sea cliffs are recorded as 800 to 1,200 feet in height, but are probably much higher. Similarly, the ice-caps farther inland are shown as having an elevation of 2,000 feet, but again are probably considerably higher.

No unconformable or disconformable relations within the Palaeozoic rocks were noted, nor is the age of the formations known, but they would appear to be early Palaeozoic. Of special note in this connection is the reported occurrence of coal inland from Croker Bay. Inspector A.H. Joy, R.C.M.P., on a patrol from Craig Harbour to Dundas Harbour and return in 1926, reports several seams of coal on a mountain inland and somewhat west of the head of Croker Bay. This suggests the occurrence of younger rocks in the interior of Devon Island, which is largely ice-capped.