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SURFICIAL GEOLOGY OF NORTHERN DISTRICT OF KEEWATIN NORTHWEST TERRITORIES

(Report, Map 7-1961 and 2 tables)

B. G. Craig

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By

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SURFICIAL GEOLOGY OF NORTHERN DISTRICT OF KEEWATIN, NORTHWEST TERRITORIES

INTRODUCTION

The map-area is bounded on the east by the 90th meridian, on the west by the 102nd meridian, on the north by the Arctic coast and the Isthmus of Boothia, and on the south by the 66th parallel.

This account is based on data collected during the 1960 field season on the helicopter-supported 'Operation Back River'. Field methods were similar to those used on previous helicopter operations (Craig, 1960[1]; Lee, 1959). Earlier studies of the glaciation of parts of the area were made by Taylor (1956) in the middle Back River region between Garry Lake and the Hermann River, and by Fraser and Henoch (1959) on Adelaide Peninsula. The surficial geology of the area immediately to the south has been described by Fyles (in Wright, 1955, pp. 3-4) and by the writer (in Wright, 1957, pp. 4-5).

This area, like other parts of the 'barren lands', displays an abundant variety of glacial landforms. The eskers are mostly long, simple, sharp-crested ridges. They exhibit a dendritic pattern, especially in the southern part of the area where they are most numerous. Eskers in the south-central part are commonly flanked by extensive flat aprons of outwash sand and gravel, which here and there obliterate the esker ridge. Large flat areas of outwash sand also occur in the southwestern corner of the map-area, but these are not as intimately associated with the eskers as the outwash aprons. The sands have been reworked slightly by the wind.

Most of the drumlins in the map-area are individual hills, up to 100 feet high and a mile long. A striking drumlin field comprises the central and northern part of Adelaide Peninsula. Crag-and-tail hills commonly occur with the drumlins and indicate the absolute direction of ice-movement. Fluting is not as common as in other parts of the Northwest Territories, but does occur as long low ridges and furrows north and west of Shepherd Bay. End-moraine ridges were observed in the northwestern corner of the map-area and southwest of Chantrey Inlet. They range in height from 25 to 40 feet, and are arcuate in plan, concave to the south, and commonly steeper on the south side. Their surface is generally covered with large, coarse, angular boulders, but as the morainal ridges all occur well below the limit of marine submergence, the material comprising them

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

has been modified by wave action in many places. Patches of minor moraines occur throughout the area, but only those south of Pelly Bay and on the west side of Chantrey Inlet were examined on the ground. In both these localities the ridges are 7 to 10 feet high, sinuous to arcuate in plan, and mostly concave to the south. Their surfaces are composed of coarse subangular boulders that lie on coarse gravel. These moraines also have been modified by marine action.

PATTERN OF ICE-RETREAT

The pattern of drumlins, crag-and-tail hills, striae, and to some extent that of the eskers and moraines, indicates an orderly retreat of the ice-front from the sea-coast to the south boundary of the map-area. Ice-movement was to the northeast across Boothia Peninsula and the eastern side of Adelaide Peninsula, and to the northwest across the remainder of Adelaide Peninsula and the land south of Queen Maud Gulf. Movement in the southern part of the area was to the northwest. This area is part of the central zone of the Wisconsin ice-sheet, within which the ice-margin retreated rapidly and regularly with no periods of marginal fluctuation (Craig and Fyles, 1960, pp. 6-7). A short period of still-stand is represented by the end moraines, but these are neither extensive nor of great size and probably can be related to local topographic conditions. One of the most significant factors in determining direction of ice-movement in the central zone was rapid or accelerated wastage into bodies of standing water. Ice-flow features in the northern part of the area suggest that arms of the sea entered the Gulf of Boothia and Queen Maud Gulf before a similar arm—through James Ross Strait into Rae Strait and Rasmussen Basin—affected the direction of flow at the ice-margin. Ice-flow features in the southern part of the area indicate retreat towards the Keewatin ice-divide, which was less than 200 miles from the south end of Chantrey Inlet (Lee, Craig, and Fyles, 1957; Craig and Fyles, 1960, p. 7).

POST-GLACIAL MARINE SUBMERGENCE

Abandoned strand lines, deltas, and thick deposits of marine silt and clay indicate that post-glacial marine invasion was extensive in the area. Storm beaches and ice-pushed ridges are widespread throughout the formerly submerged zone. West of Chantrey Inlet and between Shepherd and Spence Bays they form concentric rings around nearly all the drift hills; they are particularly striking in the drumlin field on Adelaide Peninsula and along the eskers in the northwestern part of the map-area. The thickest deposits of silt and clay, up to 300 feet, are found south of Pelly Bay, especially along the valley of Arrowsmith River where extensive badlands have developed. Such deposits are also common along the southwest-trending part of the Hayes River valley and south of Queen Maud Gulf. Throughout most of the area they are light grey in colour, but south of Queen Maud Gulf they are brick-red; in most places they are pebbly. Fossils—mostly pelecypod shells, but including shells of gastropods

and barnacles, and at one locality brachiopods—are common in the bottom sediments and in some deltaic sands. The distribution of fossils[1] is shown in Table I.

The limit of marine submergence indicated on the map accompanying this report is based on several criteria of varying reliability. In many places a distinct change in the drift is reflected in the pattern observed on air photographs and is obvious in the nature of the drift on the ground. The change is marked commonly by an ice-pushed boulder ridge. Above such a ridge are found perched boulders, generally angular, and, in many places, very coarse till. Below the ridge, perched boulders are rare or absent—those present are less angular—and much of the ground surface consists of fine material, commonly silt similar to known marine silt.

East of the lower reaches of Hayes and Mistake Rivers, altimeter measurements of the upper limit of marine submergence showed a general accordance over several miles. The extent of this submergence can be located precisely in some places where abrupt scarps rise higher than the marine limit as determined by other criteria. East of Inglis Bay, for example, an abrupt scarp rises well above the marine plain that lies to the west of it. By extrapolation on the basis of the elevation of the ground surface, as determined by several hundred altimeter readings, the marine limit has been extended from areas where it has been determined with considerable certainty, into adjoining areas, especially the northeastern part of the map-area. It is possible that many small areas on Boothia Peninsula that may formerly have been islands were not recognized. The inland limit of marine features and deposits is relatively abrupt in the southwestern half of the map-area. North of the position of the marine limit, as mapped, strand lines are common on all the hills, especially on the eskers, end moraines, and on many drumlins. Deposits of grey and red silt are widespread, and although none has yielded marine mollusc shells more than a few miles inland from the present coast, the deposits closely resemble known marine silt and are found at elevations compatible with that assumed for the marine limit.

Available evidence, although scanty, indicates that an arm of the sea probably extended up the valley of Back River. High-level deltas were found at the mouth of Hermann River and a few miles to the north, but no beaches or marine fossils were observed. Patches of silt of either marine or lacustrine origin, and poorly defined beaches up to about 550 feet, have been observed by Fyles (personal communication) in the Back River basin south of the area as far west as Macdougall Lake. Marine shells indicate the former presence of the sea in the southeastern corner of the map-area; it is unlikely that this arm of the sea was extensive, however, for the lake where the marine shells were found is confined in steep high walls.

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[1] Fossil identifications by F.J.E. Wagner, Geological Survey of Canada.

The elevation of the marine limit is lower in the western half of the map-area than it is in the northeastern quarter. South of Queen Maud Gulf the marine invasion did not cross the Back River divide, which is about 625 feet above sea-level northeast of Armark Lake, but lay probably 50 to 75 feet below that elevation. Southeast of Chantrey Inlet, the elevation of the marine limit is at about 500 feet above present sea-level. It increases to about 600 feet south of Lady Melville Lake, to about 650 feet south of Pelly Bay, and to almost 700 feet in the northeastern corner of the map-area. In the southeastern corner the limit is probably at the same elevation as it is around Wager Bay, where it has been established at about 400 feet (Bird, 1954, p. 460).

RADIOCARBON AGE-DETERMINATIONS

Radiocarbon ages were determined for marine shells from five localities (see Table II). Shells from localities 2 and 7 were

Table II

List of Radiocarbon Dates

Locality No. (see Map 7-1961)	Dating No.	Elevation of Sample (feet above sea-level)	Radiocarbon Age (years)
2	I(GSC)-215	575	8,360 ± 175
7	I(GSC)-179	540	8,370 ± 200
19	I(GSC)-213	293	7,880 ± 150
28	I(GSC)-212	176	7,160 ± 160
40	I(GSC)-178	72	3,690 ± 120

collected from bottom sediments and cannot be used to determine the precise height of the sea at the time they were deposited. However, these shells are from two of the highest (above sea-level) collections made in the area and probably were deposited close to the time of maximum marine transgression, shortly after the sites became ice-free. This event took place some 2,000 years later here than it did near the western extremity of the Wisconsin ice-sheet (Craig, 1960, p. 6), which provides further support to the pattern of deglaciation suggested by Craig and Fyles (1960, p. 6).

The shells from localities 19 and 28 were collected from the foreset beds of deltas and those from locality 40 from a low sandy beach. The shells from these three localities represent deposition when the water plane stood very close to the level at which they were found.

Because of the proximity of the four highest localities to one another in an area where there were no great differences in the time of deglaciation, the data they provide are considered adequate to make a tentative estimate of the rate of emergence during the early phases of isostatic readjustment. Lee (1960, p. 1611) has stated that around the east side of Hudson Bay the uplift took place more rapidly in its initial stage than it did towards the end of the period of readjustment. The rates of emergence in the present area are greater than those suggested by Lee, but do agree with his general conclusion that the "rate of land emergence decreased exponentially". It is likely that the data for the four highest localities (Table II) would lie on the steeper part of a similar curve than those used by Lee.

The data provided by the lowest locality (No. 40, Table II) cannot be used directly in deriving rates of emergence, but they do indicate that although the Wisconsin ice-sheet had melted away by the time the shells were deposited (Craig and Fyles, 1960, p. 10), isostatic readjustment was still incomplete.

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APPENDIX

Palaeontological Remarks on Shells Collected on 'Operation Back River'

by F.J.E. Wagner

Several marine-animal communities have been delimited in East Greenland waters (Ockelmann, 1958), and these have since been recognized in the eastern Canadian Arctic. The *Macoma* community, which occurs in shallow waters to depths of about 50 metres, has also been found along the southern fringe of the Queen Elizabeth Islands, in Dolphin and Union Strait, and west as far as Point Barrow, Alaska. This community may contain a distinct *Astarte* zone between depths of 5 and 20 metres, characterized by *Astarte borealis* and *A. montagui*. In areas off glaciers and river mouths where there is a considerable inflow of fresh water, the *Yoldia arctica* community replaces the *Macoma* community. Depths for the *Yoldia* community range between about 10 and 60 metres. Some of the species of the *Macoma* community may be present but on the whole the *Yoldia* community is poor in numbers of species. The *Gomphina fluctuosa* community occurs at similar depths to the *Macoma* community, but is characteristic of areas of sandy bottoms. The *Astarte crenata* community and the Foraminifera community are indicative of depths greater than 50 metres.

Pleistocene assemblages from the following localities might be referred to the *Macoma* community:

— 50 m.

GSC Loc. No.	Loc. No. on Map 7-1961	Elevation (feet above sea-level)
43754	3	560
43719	17	340
43718	19	293
43730	23	243
43742	24	236
43736	27	184[1]

[1] *Macoma calcarea* is absent, but the assemblage includes other species characteristic of the *Macoma* community.

Assemblages possibly referable to the Astarte zone of the Macoma community are those from the following localities:

5-20 m.

GSC Loc. No.	Loc. No. on Map 7-1961	Elevation (feet above sea-level)
43717, 43753	28, 29	176[2]
43740	30	160
43716	33	120
43734	34	118
43735	35	100
43737	40	72
43746	41	55
43744	44	26
43709	45	20
43711	46	15
43723	47	10

Three assemblages may represent the Yoldia arctica community. These are from the following localities:

10 60 m.

GSC Loc. No.	Loc. No. on Map 7-1961	Elevation (feet above sea-level)
43724	7	540
43722	13	435
43750	14	400

The other localities have too few species present for their community affinities to be postulated. However, none of the assemblages even hints at any connection with the Gomphina fluctuosa community, or the deeper Astarte crenata and Foraminifera communities. The conclusion is that the assemblages from the lower elevations (below about 180 feet above sea-level) lived in shallower waters than those from the higher elevations, although in no case was the water probably deeper than about 50 metres.

All of the species, except Bathyarca glacialis and Pseudamussium binominatus, are of circumboreal distribution. B. glacialis is a typically Eastern Arctic form. P. binominatus is known living only from the type locality (Dolphin and Union Strait), but it has been found in the late Pleistocene or early Recent deposits of the Moosonee area, Ontario.

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[2] See previous footnote. Well-preserved Mytilus edulis is also present, indicating very shallow depths.