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PLEISTOCENE GEOLOGY OF ARCTIC CANADA

B. G. Craig and J. G. Fyles

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By

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PLEISTOCENE GEOLOGY OF ARCTIC CANADA[1]

INTRODUCTION

In Arctic Canada as in the more southerly part of the country, the Pleistocene epoch involved a succession of glacial and interglacial intervals. Thus far, only two or perhaps three glaciations have been recognized but it is expected that future work will provide evidence of others. Some glaciated areas apparently were not overridden by ice during the latest (Wisconsin)[2] glacial invasion. The interglacials remain almost entirely unknown except for a few local records of climatic conditions slightly warmer than the present.

This summary of the Pleistocene history of Arctic Canada is presented as a preliminary account, subject to revision as more adequate information becomes available. Some parts of the region and parts of the geological record are treated in greater detail than others, and the Cordillera is omitted entirely from the discussion. Much of the information pertaining to the Districts of Keewatin and Mackenzie and to Banks and Victoria islands is based upon our own observations, and those of H.A. Lee, gained in the course of large-scale airborne operations covering about 450,000 square miles. In compiling data on the Arctic Islands we have drawn upon unpublished information and ideas of our colleagues at the Geological Survey of Canada; this assistance is gratefully acknowledged.

EXTENT OF GLACIATION

The ice that covered northern Canada during the last glaciation and probably during earlier ones as well, consisted of three principal ice-sheets or glacier complexes (see Fig. 1) that partly coalesced with one another during their maximum stand. The area marked 'Wisconsin Laurentide ice-sheet' in Figure 1 is characterized by fresh glacial landforms built by the mainland North American continental glacier during the last glaciation. The border of this ice-sheet is arbitrarily placed at the outer limit of such landforms, although future work may show that the ice extended somewhat farther. The Laurentide ice-sheet was bordered on the west by the Cordilleran ice-sheet and on the northeast by a similar glacier complex that occupied Baffin, Devon, Ellesmere, and adjoining islands. Most of the present land area of these islands has been glaciated, probably by a series of local ice-caps that, at their maximum

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[1] This report is one of several summary papers prepared by officers of the Geological Survey of Canada and presented at the First International Symposium on Arctic Geology, Calgary, Alberta, 1960. Preliminary publication is by arrangement with the organizing committee of the symposium.

[2] In this report the term Wisconsin applies to the last major expansion and retreat of the North American ice-sheets and thus is intended to include only the "classical" Wisconsin of some authors.

stand, coalesced with one another and with the Laurentide ice-sheet. Evidence of Wisconsin glaciation has not been distinguished from that of earlier glaciations on these islands.

The boundary between the Laurentide and Baffin ice-sheets in Figure 1 is drawn through Hudson Strait and Foxe Basin along the confluence of ice-flow trends (see Fig. 4). It is probable, however, that these trends relate to the time of glacial retreat rather than the maximum stand of the ice, and that the Baffin and Laurentide ice-sheets merged completely at the glacial climax. Taylor (1956)[1] and Bird (1959, p. 157) have even suggested that an early 'high' on the ice-sheet surface coincided with Foxe Basin. Farther to the northwest on Somerset and Prince of Wales islands, little evidence is available regarding the extent of Laurentide ice, of regional ice from a more northerly source, and of local ice-caps. The Laurentide boundary is tentatively placed between southern lowlands with fresh glacial landforms and northern highlands that are reported to bear only indefinite evidence of regional glaciation. Southeastern Melville Island, western Banks Island, and a coastal strip of the mainland on both sides of Mackenzie River contain Laurentide glacial deposits but lack the constructional glacial landforms that characterize the regions to the south and east. Probably these areas lay beyond the northwestern limit of the Laurentide ice-sheet during the last (Wisconsin) glaciation, even though they were previously overridden by the ice-sheet.

On the western Queen Elizabeth Islands, the only conclusive evidence of glaciation recognized thus far has been ascribed to local ice-caps. On the other hand, a suggestion of more extensive (possibly pre-Wisconsin) glaciation is provided by widespread erratic boulders and by raised marine features. Erratic stones have been reported on all the islands and at all elevations, although in places they are exceedingly rare. They apparently have come from sources to the east and southeast, as if distributed by a regional ice-sheet. Alternatively, however, they may have been emplaced by rivers prior to dissection of the archipelago and by ice rafting during submergence. Likewise, the raised marine features could possibly relate to high interglacial sea-levels or to uplift that was not associated with glaciation.

PRE-WISCONSIN GEOLOGY

Pre-Wisconsin surficial features are to be found mainly outside the areas of Wisconsin glaciation; that is on the western Queen Elizabeth Islands, on Banks Island, on the Arctic Coastal Lowlands near Mackenzie River, and (beyond the scope of this report) in the Yukon basin.

Beaufort Formation

The Beaufort formation of late Tertiary and perhaps earliest Pleistocene age (Tozer, 1956) occupies the western parts of all the westernmost Arctic Islands from Meighen Island to the south coast of

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[1] Dates or names and dates in parentheses refer to publications listed in the References.

Banks Island (see Fig. 2). The Beaufort deposits, ranging up to 200 feet or more in thickness, consist of gravel, sand, and some silt and contain much fresh uncompressed driftwood. A large proportion of the pebbles consist of resistant rocks such as chert and quartzite that appear to have been derived from distant sources to the east and southeast. The Beaufort strata seem to be remnants of a continuous fluvial-plain complex deposited by vigorous streams, apparently prior to the dis-section of the western islands.

In outcrop, the Beaufort strata are horizontal or have local erratic dips, but the regional distribution of the formation suggests that it slopes gently to the west and northwest parallel to the general direction of flow of the depositing streams. This dip may reflect only the gradient of these streams, or may be the combined result of initial stream-gradient and regional tilting. Linear markings on the surface of the Beaufort formation on Prince Patrick Island have been interpreted as the traces of faults (Thorsteinsson and Tozer, 1959).

Preliminary pollen studies of the Beaufort have been undertaken by J. Terasmae of the Geological Survey of Canada. At Cape Kellett on southern Banks Island the pollen flora of the lower part of the Beaufort contains abundant northern conifers including spruce, pine, fir, and hemlock, and a small but significant amount of temperate hardwoods such as elm, hazel, and hornbeam; birch, willow, alder, and herbaceous plants are also represented. The same assemblage has been found in samples of the Beaufort formation from Borden and Ellef Ringnes islands. In contrast, the upper part of the Beaufort at Cape Kellett as well as samples from south-central and northern Banks Island have yielded a pollen assemblage dominated by spruce and pine and lacking the hardwoods and hemlock found below. Coal-bearing rocks that lie beneath the Beaufort formation on Banks Island are a possible source of the hardwood pollen, but the complete absence from the Beaufort of other distinctive elements of the early Tertiary flora contained in these rocks suggests that the hardwood pollen is not secondary material but rather an indigenous part of the Beaufort assemblage.

The Beaufort formation appears to represent a late stage in the transition from the warm climate of the middle Tertiary to the cool Pleistocene. The pollen flora in the lower part of the Beaufort formation represents a warmer climate than would be expected in this region during the warm (interglacial) parts of the Pleistocene and is tentatively considered to be late Tertiary. Similar floras from Alaska (Hopkins and Benninghoff, 1959; Benninghoff and Holmes, 1959) and from Siberia (Fradkina, 1959) have likewise been assigned to the late Tertiary. On the other hand, all critical components of the flora of the upper part of the Beaufort are identical to those in overlying Pleistocene (interglacial?) deposits on Banks Island, as if deposition of the Beaufort continued into earliest Pleistocene time.

Dissection of the Beaufort fluvial plain into the present system of islands and straits, and development of the present topography of the western islands probably began early in the Pleistocene, and may have continued at various times later in the Pleistocene. On Banks Island the Beaufort gravels now cap ridges between valleys up to 1,000 feet deep that predate at least one glaciation. The straits and sounds between the islands appear to be part of an ancient system of river valleys (Fortier and Morley, 1956). The westernmost parts of these valleys apparently have been cut through the Beaufort formation and are thus inferred to have originated in Pleistocene time, but the more-easterly upstream parts may have originated earlier.

Interglacial and Old Glacial Deposits, Arctic Islands

On western Banks Island outside the inferred boundary of the Wisconsin Laurentide ice-sheet, till deposited by an older (?) Laurentide ice-sheet rests upon the Beaufort gravels. Overlying the till are pockets of pond silt (known localities marked, Fig. 2), that contain peat yielding a meagre amount of pollen and that are associated in one place with small trees and beaver sticks. The pollen flora of spruce, pine, birch, alder, and tundra plants (J. Terasmae, personal communication) records climatic conditions considerably warmer than those of the area today and hence probably dates from an interglacial. Wood from one of the trees has a radiocarbon age of greater than 35, 000 years (dating No. I (GSC)-19) Stony material covering these silts may constitute another glacial deposit (pre-Wisconsin ?), or may merely be colluvium.[1]

Two isolated occurrences of plant-bearing, possibly interglacial deposits have been found on the Queen Elizabeth Islands (Prest, in Stockwell, 1957, p. 457). Peat from near Eureka on Ellesmere Island contains pollen of spruce, pine, birch, and alder as well as pollen of the tundra plants found in the region today (pollen analysis by J. Terasmae) and records a time when the area was at least partly forested. Peat from beneath thin marine deposits in central Bathurst Island has yielded a tundra pollen assemblage together with scant pollen of spruce and birch. The tree pollens are so few in number that they may have been blown from a distant source. Hence the climate under which this peat accumulated need not have been warmer than the present. The position of these two deposits in the glacial chronology is not known.

Mackenzie River Region

Unconsolidated clays, silts, sands, and gravels up to several hundred feet thick lie beneath the Arctic Coastal Plain on either side of Mackenzie River (Fig. 2) from Cape Bathurst westward to the Alaska boundary and beyond (O'Neill, 1924; Mackay, 1956a, 1956b, 1958). They probably include several distinct geological units deposited at various times during the Pleistocene and perhaps also in the late Tertiary. On the basis of their regional geographic position only, they might be expected to contain equivalents of the Pleistocene Gubik formation of the Alaska Coastal Plain and of the Beaufort formation. These deposits have been overridden by Laurentide glacial ice, possibly during a pre-Wisconsin glaciation. Widespread deformation of the strata has been

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[1]Since this report was presented, a radiocarbon age of greater than 38, 000 years (dating No. I (GSC)-26) has been assigned to willow twigs from peat overlying this succession and containing pollen of birch in addition to that of tundra plants. The peat is uncompressed and hence has not been overridden by glacial ice. The radiocarbon age supports the inference that the western part of Banks Island was not glaciated during the Wisconsin.

attributed to thrusting by glacial ice (Mackay, 1956b, and unpub. manuscripts). Many of the deposits contain wood and peat and appear to be fluvial; others contain marine shells; and a few have yielded remains of mammoth and bison. Mackay (1956a) has suggested that the deposits east of Mackenzie River constitute an ancient delta (or deltas) of the river.

Buried peat from a thick section of apparently fluvial deposits exposed in the bank of the east channel of Mackenzie River has yielded pollen indicative of vegetation similar to that growing in the region today. The deposit is inferred to be interglacial (Terasmae, 1959). Peat from the same strata in a nearby exposure has a radiocarbon age of more than 44,000 years (date number L 522A), and wood from similar materials exposed in a pingo some 50 miles to the northeast has an age of more than 33,000 years (L 300A).

Gravels lying beneath till have been reported at a number of places along Mackenzie River south of the region discussed above (McConnell, 1891). Some of these gravels may have been buried beneath glacial deposits by post-glacial slumping along the river-bank, but the writer (B.G. Craig) has observed that others are certainly interglacial or preglacial. So far, none of these gravels has yielded fossil organic remains.

THE WISCONSIN LAURENTIDE ICE-SHEET

Significance of Glacial Features

Within the area covered by the Laurentide ice-sheet during the last glaciation an abundance of striking glacial features is displayed. These include moulded rock surfaces, crag-and-tail hills, drumlinoid forms, esker complexes, end-moraine ridges, hummocky and ground-moraine areas, and shorelines marking higher levels of the sea and the borders of extinct glacial lakes. The recently published Glacial Map of Canada (Geol. Assoc. Can., 1958) has brought to general attention the radial patterns of glacial-flow features and of eskers on the Precambrian Shield and adjoining regions. Drumlinoid features, eskers, and minor moraines are closely associated both in areal distribution and in time and environment of origin. It is therefore apparent that the radial ice-flow patterns record successive positions of the margin of the ice-sheet and successive ice-movements near the margin during deglaciation (Lee, Craig, and Fyles, 1957; Lee, 1959). It follows that these features cannot be used to determine the position of highs on the ice-sheet, nor do they indicate direction of flow in the interior of the ice-sheet during its build-up or its climax. In some places, deformed drumlins and anomalous and intersecting glacial striae have been found. Generally these can be related to fluctuations of the marginal zone or changes in the pattern of retreat, although some striae have been observed that must be the result of an ice-movement earlier than that recorded by the majority of surface features in their vicinity.

Nevertheless, certain inferences can be drawn regarding directions of ice dispersal in the interior of the ice-sheet. It is well known that erratics have been transported from the Precambrian Shield outward in all directions to the peripheral zone of the ice-sheet up to several hundreds of miles from their source. There is no assurance, however, that either the distance or direction of net transport of such erratic stones records actual flow lines within the ice-sheet. Rather they may be the resultants of successive shorter movements in various directions. The directions of transport suggested by the position of the erratics are known to differ locally from the direction of ice-movement indicated by ice-flow features. For instance, Lee (1959, p. 23) cites evidence of southward transport of erratics west of Hudson Bay where ice-flow features record radial flow. Inferences regarding variations in thickness of the ice-sheet at its maximum stand can be drawn from changes in elevation of raised marine features and shorelines of extinct glacial lakes formed when the land was depressed isostatically by the ice-load. Variations in the elevation of these features and their relation to the thickness of the ice-sheet at its maximum stand will be discussed later. It suffices to say here that these features indicate a significant thickening of the ice in the marginal zone a few hundred miles wide, but that they provide no clear evidence of further significant thickening in the interior zone about a thousand miles in diameter. Geophysical data (e.g. Fischer, 1959) suggest that isostatic readjustment is still incomplete in the general region of southern Hudson Bay as if this area originally had supported the maximum thickness of ice.

Pattern of Deglaciation

The area covered by the Wisconsin Laurentide ice-sheet in Arctic Canada, as it does farther south, consists of a peripheral zone that appears to have been the locus of marginal fluctuations during the maximum and early phases of shrinkage, and a central zone across which the ice-margin retreated more rapidly and regularly into the areas of last remnant-ice in Keewatin and Labrador. At the climax of glaciation the peripheral zone probably was covered by ice that was thinner than that of the central zone.

The peripheral zone is characterized by large and numerous morainal features. It includes the classical areas of Wisconsin glaciation in the Great Lakes region and extends to the west and northwest across the Great Plains. Our work in Arctic Canada has shown that it continues northward between the Precambrian Shield and the Cordillera to the Arctic coast and across eastern Banks Island and western Victoria Island. Figure 3 illustrates the pattern of morainal ridges and belts on western Victoria Island and eastern Banks Island. In this area the ice apparently was never very thick and as deglaciation progressed the ice soon stagnated on the high land and then separated into active lobes and tongues in the depressions now occupied by arms of the sea. On the mainland, north of the western part of Great Bear Lake and on southwestern Victoria Island are vast areas of hummocky moraine with tremendous kame hills and in some places end-morainal ridges of considerable size. Glacial deposits of this sort lie between the Cordillera and the Shield at least as far south as the provincial boundary, although not continuously. West of Great Slave Lake a thick lobe of Laurentide ice apparently impinged directly on the mountains and spread northward along the Mackenzie Valley and southward along the mountain front. In this area the peripheral belt is inconspicuous and is represented only by small moraines close to the foot of the mountains.[1] West of the Shield this zone of large moraines and thick drift coincides with the area of soft bedrock, and may, to some degree, merely reflect the erodability of these rocks.

The central zone is characterized by a profusion of eskers and drumlinoid features, and lacks large moraines of the type found in the peripheral zone although it contains fields of minor moraines. It lies mainly on the Precambrian Shield. Glacial features of the central zone (Fig. 4) indicate a more or less orderly retreat of the ice-margin toward the interior of the Shield. Local deflections in ice-flow directions near the ice-front relate to topographic control or increased wastage into bodies of standing water. Late in the retreat, the sea penetrated through Hudson Strait into Foxe Basin and Hudson Bay, and the ice-sheet separated into isolated remnant bodies. The direction of ice flow in parts of these remnants was towards the recently opened marine embayments and probably was radically different from flow directions in the same areas prior to the marine invasion. On the mainland such remnant bodies existed both east and west of Hudson Bay. On the west side of the bay the last ice occupied a linear zone that has been termed the Keewatin ice-divide (Lee, Craig, and Fyles, 1957; Lee, 1959).

A distinct discontinuity in the flow features in the northwest quadrant of the Wisconsin Laurentide area indicates that in this part of Arctic Canada the ice-sheet retreated as two separate lobes. As shown in Figure 4, this discontinuity lies approximately along the Arctic mainland coast from the west boundary of the ice-sheet to Bathurst Inlet and thence extends inland southward and southeastward in a broad arc to the south end of the Keewatin ice-divide. Near the west end of this discontinuity, Mackay (1958, pp. 35-38) distinguished the two lobes but found no evidence to indicate whether they were synchronous or that one predated the other. Northwest of the west end of Coronation Gulf, a small end moraine presumably built by the northern lobe has been overridden and drumlinized by ice of the southern lobe. Intersecting glacial striae give further support to this conclusion, although a sharp bend in the trend of flow features suggests a fusion of the two ice lobes. Closer to the ice-divide in the Thelon basin (Craig, in Wright, 1957, p. 5) a proglacial lake, held up by ice of the northern lobe, invaded the area crossed by the southern lobe. We suggest that this lobation and the resultant discontinuity in the ice-flow features is due to topographic control. From the west end of the discontinuity to within 200 miles of the Keewatin ice-divide, the land to the south and west of this line is a few hundred feet to more than 2,000 feet higher than that to the north. Moreover, throughout much of this distance the discontinuity lies more or less parallel to, and a few miles southwest of, a remarkably continuous valley[2]. This break in the pattern of flow features reflects a

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[1]North of the provincial boundary no definite occurrences of Cordilleran glacial material have yet been found on the plains.

[2]Oceanographic work has shown that this valley (termed the Amundsen Trough, Carsola, 1954, p. 366) extends westward to the edge of the Continental Shelf.

boundary between slowly moving, locally stagnating ice on the high land to the south, and actively flowing ice in the low land to the north, especially through the trough. Although the easternmost 200 miles of the discontinuity is well marked, there is no difference in elevation of the land surfaces on either side of it. Possibly at this stage in the ice-retreat the area that had been covered by the southern lobe became ice-free.

GLACIAL LAKES

Proglacial lakes were formed as the ice-front retreated, both by damming of natural drainage lines by ice and by differential isostatic depression. These extinct glacial lakes are indicated mainly by strand-line features but locally by bottom deposits and deltas. Because of the reconnaissance nature of most of the work done in the area, only the largest of these lakes have been studied in any detail. Probably the largest lake that was formed was that in the Great Slave - Great Bear basins, and along the topographic low that lies between them. This lake was more extensive than has been shown previously. Its highest beaches are now slightly more than 900 feet above sea-level and about 400 feet above the present level of the lakes. The connection between the two lakes has not been mapped completely but there is little doubt that it existed. A southward extension of this lake extended along the Slave River valley, in which direction the lake drained during its early stages. Studies of beach elevations along the eastern half of the north shore of Great Bear Lake indicate an upwarping to the east of about 300 feet in slightly more than 100 miles.

Smaller proglacial lakes formed later in the retreat of the ice-sheet by damming of the natural eastward drainage by the ice. In the Thelon River valley, beaches indicate a progressive eastward lowering of an ice-dammed lake as successively lower outlets were uncovered. The highest beaches are found at about 1,250 feet at the upper end of the basin (Craig, in Wright, 1957, p. 5) and at about 700 feet around Beverly Lake (Fyles, in Wright, 1955, p. 3). Possibly the highest stage drained to the south and the lower and later stages to the north across the Back River divide. It is also possible that during its final stage it merged with an arm of the sea that extended up Chesterfield Inlet and Baker Lake.

Hyper-Dubawnt Lake, described originally by Tyrrell (1898, p. 190) is represented by beaches up to 900 feet above sea-level on the east side of the present lake (Fyles, in Wright, 1955, p. 3) and is probably represented by beaches up to 1,100 feet in elevation farther up the drainage system. It is possible that this lake and that in the Thelon basin were interconnected early in their history.

Lee (1959, p. 15) has recently described a glacial lake occupying the Ennadai Lake - Kasba Lake basin, glacial Lake Kasba, whose highest beaches are about 1,260 feet above sea-level.

SEA-LEVEL CHANGES

Pleistocene and Recent marine shells, strand lines, and offshore deposits extend above present sea-level along almost all the coasts of Arctic Canada. In contrast, some river-cut valleys along the westernmost coasts extend below present sea-level. The raised shoreline features are characterized by remarkable flights of shingly beach ridges but generally lack prominent wave-cut scarps. Offshore deposits are mostly thin, except those adjacent to former mouths of large rivers. An area of thick, dominantly marine deposits borders parts of Coronation Gulf and Dolphin and Union Strait.

Figure 5 is a compilation of the highest records of marine submergence throughout Arctic Canada. Only in parts of the region are there enough data to make a reliable estimate of the upper limit of this submergence. In making this compilation, questions have arisen as to whether an elevation measurement is of the proper order of magnitude; whether a reported strand line is truly marine; whether marine shells were found in their place of growth; and whether (in the Arctic Islands) shells are Pleistocene or have weathered out of Mesozoic rocks. A few records have been omitted from the map because of such uncertainties.

In a zone 100 to 500 miles wide bordering Arctic Canada, the highest marine features range from a few feet to about 800 feet above present sea-level and increase more or less regularly in elevation from the outermost land to the interior. A comparable increase in height of former marine submergence occurs in a belt of about the same width along the Atlantic and Pacific coasts of North America as far south as the Wisconsin glacial boundary. Inside this border zone, the limit of marine submergence ranges from 400 to 900 feet above present sea-level and varies irregularly from place to place.

Within the areas formerly covered by the Wisconsin Laurentide ice-sheet and the Ellesmere-Baffin glacial complex, the raised marine features record uplift during and following the wastage of the Wisconsin ice. As yet, significant intervals of stillstand or of rise of sea-level relative to the land have not been distinguished. The uplift is believed to have resulted from removal of the weight of the glacial ice from the crust of the earth, and to give some indication of regional variations in the thickness of the ice-sheet at its maximum stand. However, the present elevation of the highest, earliest marine features at any locality is less than the isostatic uplift at that locality because some of the uplift took place before ice-retreat permitted entry of the sea, and because an absolute rise of the sea was in progress during the time of uplift. The amount of rebound prior to marine invasion varied in magnitude from place to place and probably was greater in the interior parts of the glaciated region (deglaciated late) than in the peripheral parts (deglaciated early). This factor is therefore a source of uncertainty in using regional changes in elevation of the upper limit of marine submergence to reconstruct the thickness profile of the ice-sheet. Nonetheless, the pattern of regional changes in elevation of the highest marine features (see Fig. 5, and foregoing description) suggests that the Laurentide ice-sheet thickened progressively for a few hundred miles from its outer margin towards its interior but did not increase much further in thickness throughout its interior. The irregular changes in highest marine level in the interior of the glaciated area may relate as much to differences in the time of ice-retreat (and hence of marine invasion) as to differences in former glacial thickness. Support for this contention is provided by the 'low' in marine levels in the neighbourhood of the Keewatin ice-divide, which is believed to be the zone occupied by the last glacial remnant west of Hudson Bay.

Little is known as yet about the extent and age of marine submergence of the western Queen Elizabeth Islands, Banks Island, and the Arctic Coastal Lowland near the Mackenzie River. Many of the raised marine deposits in the Mackenzie River area have been deformed, probably by glacial ice (Mackay, 1956b), so that their present elevation may not give a reliable record of the extent of former submergence. On western Banks Island, an indistinct shoreline(?) about 50 feet above present sea-level is visible on air photographs, but clear evidence of marine overlap has yet to be recognized on the ground. The elevation of the highest recorded marine features on the western Queen Elizabeth Islands (Fig. 5) apparently increases in a general way from northwest to southeast, but also changes erratically from one island to another. Possibly two or more ages of submergence are involved, perhaps related to pre-Wisconsin events as well as to rebound resulting from melting of local (?) Wisconsin ice-caps.

Some river-cut valleys along the west coasts of the western Queen Elizabeth Islands and Banks Island and along the mainland coast west of Cape Bathurst have been 'drowned' by the sea. This transgression probably took place during the eustatic rise of sea-level that accompanied the melting of the last ice-sheets.

RADIOCARBON DATES

Most of the available radiocarbon dates on post-glacial materials from Arctic Canada appear in Figure 6 and Table I. They indicate that deglaciation of the northern part of the continent took place at about the same time as retreat of the ice-sheet from southern Canada. The dated marine shells from northwest Victoria Island (Locality 2)[1], Coronation Gulf (Loc. 4, two older samples only), and west of Hudson Bay (Loc. 9) relate to fairly high seashores occupied soon after glacial retreat. The decrease in age of these samples from the periphery to the interior of the region formerly covered by the Wisconsin Laurentide ice-sheet lends support to the pattern of deglaciation outlined earlier.

The last remnants of the Laurentide ice-sheet west of Hudson Bay could not have survived much later than 7,000 years ago and may have disappeared earlier. This conclusion is based upon the 5,500-year sample from the Thelon River basin (Loc. 6), which originated considerably after deglaciation when the climate was warmer than at present (Craig, 1959), and upon the sample from Loc. 9 west of Hudson Bay (Lee, 1959, p. 25), which records marine conditions

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[1]Numbered localities are those in Figure 6.

only 50 miles east of the Keewatin ice-divide 7,000 years ago. Radiocarbon ages of early post-glacial peats from central Labrador (Grayson, 1956) suggest that the last glacial remnants east of Hudson Bay disappeared at about the same time as those west of the bay. The samples from Back River (Loc. 7; 4,100 years) and from Rankin Inlet (Loc. 8; 5,200 years) have been described as being older than the last glacial expansion in Keewatin (Flint, 1956; Taylor, 1956). It is more likely, however, that the dated materials were formed after complete disappearance of the ice (Craig, 1959; Lee, 1959).

The radiocarbon dates at Localities 1, 3, 10, and 13 show that the present relative positions of land and sea were established at different times in different parts of the areas of Wisconsin glaciation. Archaeological studies and radiocarbon dates at Localities 10 and 13 suggest that emergence of the land around parts of Hudson Bay and Foxe Basin was still in progress 2,000 or 3,000 years ago and perhaps even more recently. On northern Ellesmere Island (Loc. 1) emergence apparently was in progress about 7,000 years ago, but sea-level may have been more or less stable during the last 6,000 years. On western Victoria Island (Loc. 3), shells of marine molluscs that are believed to have lived when the seashore stood only 30 feet above its present level, have a radiocarbon age of 8,900 years. Thus most of the post-glacial isostatic uplift in this locality (an adjustment of 280 or 300 feet above present sea-level) took place more than 8,900 years ago. As eustatic sea-level rise appears to have continued until 5,000 or 6,000 years ago (Godwin, et al., 1958), the sea may have continued to rise after isostatic uplift of the land was complete in this marginal part of the area of Wisconsin glaciation.

Although southern Melville Island bears evidence of having been glaciated, Loc. 14 on northeastern Melville Island lies within an area that has not yielded conclusive evidence of glaciation. Nonetheless, the 8,300-year radiocarbon age of raised marine shells in this locality can only be explained readily in terms of depression of this part of Melville Island by a substantial load of glacial ice during Wisconsin time.[1]

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[1]Since completion of this report, a radiocarbon age of 8,200 ± 180 years has been assigned to marine shells collected 75 or 100 feet above sea-level on southern Lougheed Island, Queen Elizabeth Islands (dating No. I(GSC)-24). The inference presented above for the date at Locality 14 applies also to this date; Lougheed Island as yet has not yielded conclusive evidence of glaciation.

TABLE I

Radiocarbon Ages of Post-glacial Materials

Locality No. (Figure 6)	Dating No.	Age	Material	Occurrence	Collector	Reference
1	L 248A, B L 254A-D	7,200 ± 2,000 3,000 - 6,000	marine shells driftwood	beach, el. 125') beach behind ice shelf)	R.L. Christie, G. Hattersley Smith, A.P. Crary	Christie (1957)
2	I (GSC)-18	12,400 ± 320	marine shells	el. ca. 230', clay	J.G. Fyles	unpublished
3	I (GSC)-20	8,895 ± 220	marine shells	el. 25', clay in delta	J.G. Fyles	"
4	I (GSC)-17 I (GSC)-16 I (GSC)-13	10,215 ± 220 9,100 ± 180 8,290 ± 330	marine shells marine shells marine shells	el. 280', in silt el. 495', in silt el. 320', shore deposits	B.G. Craig B.G. Craig J.J. O'Neill	" " "
5	S-5, 8, 9, 10	4,100 - 5,000	peat, charcoal	archaeological site	R.S. MacNeish	MacNeish (1955)
6	L-428	5,500 ± 250	pond plants	pond silt in pingo	B.G. Craig	Craig (1959)
7	Y-261	4,140 ± 150	peat	lacustrine silts	R.S. Taylor	Taylor (1956)
8.	Y-231	5,220 ± 340	peat	beneath till(?)	Z.L. Sujkowski	Flint (1956)
9	I (GSC)-8	6,975 ± 250	marine shells	el. 210', in clay	H.A. Lee	Lee (1959)
10	P-62 P-74 P-75 P-76 P-77	2,060 ± 200 2,183 ± 122 2,508 ± 130 2,632 ± 128 2,191 ± 120	charred bone burned bone burned bone burned bone burned bone	el. 70') el. 70') archaeological el. 70') sites on el. 70') raised beaches el. 40')	H.B. Collins	Rainey and Ralph (1959)
11	S-12	3,670 ± 270	marine shells	el. 105', surface deposit	J.B. Bird	McCallum (1955)
12	S-13	5,600 ± 300	marine shells	el. 170', terrace	J.B. Bird	McCallum (1955)
13	P-207 P-208 P-209 P-210 P-211 P-212 P-213	3,958 ± 168 3,560 ± 123 3,906 ± 133 2,898 ± 136 2,354 ± 135 2,404 ± 137 2,910 ± 129	ivory antler ivory antler antler antler ivory	el. 165') el. 165') el. 165') archaeological el. 145') sites on el. 80') raised beaches el. 70') el. 70')	J. Meldgaard	Rainey and Ralph (1959)
14	I (GSC)-21	8,275 ± 320	marine shells	el. 175', surface material	E.T. Tozer	unpublished

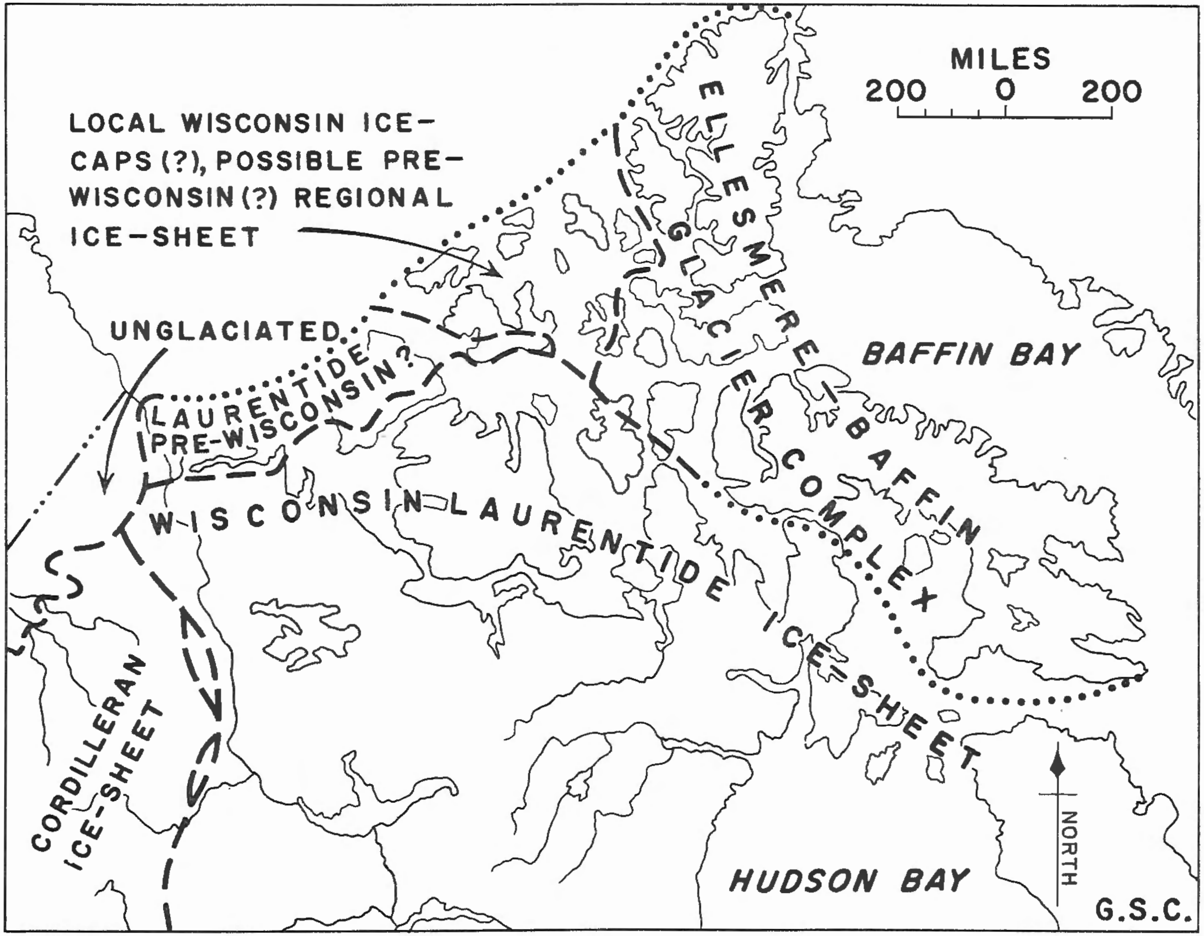

Figure 1. Extent of glaciation.

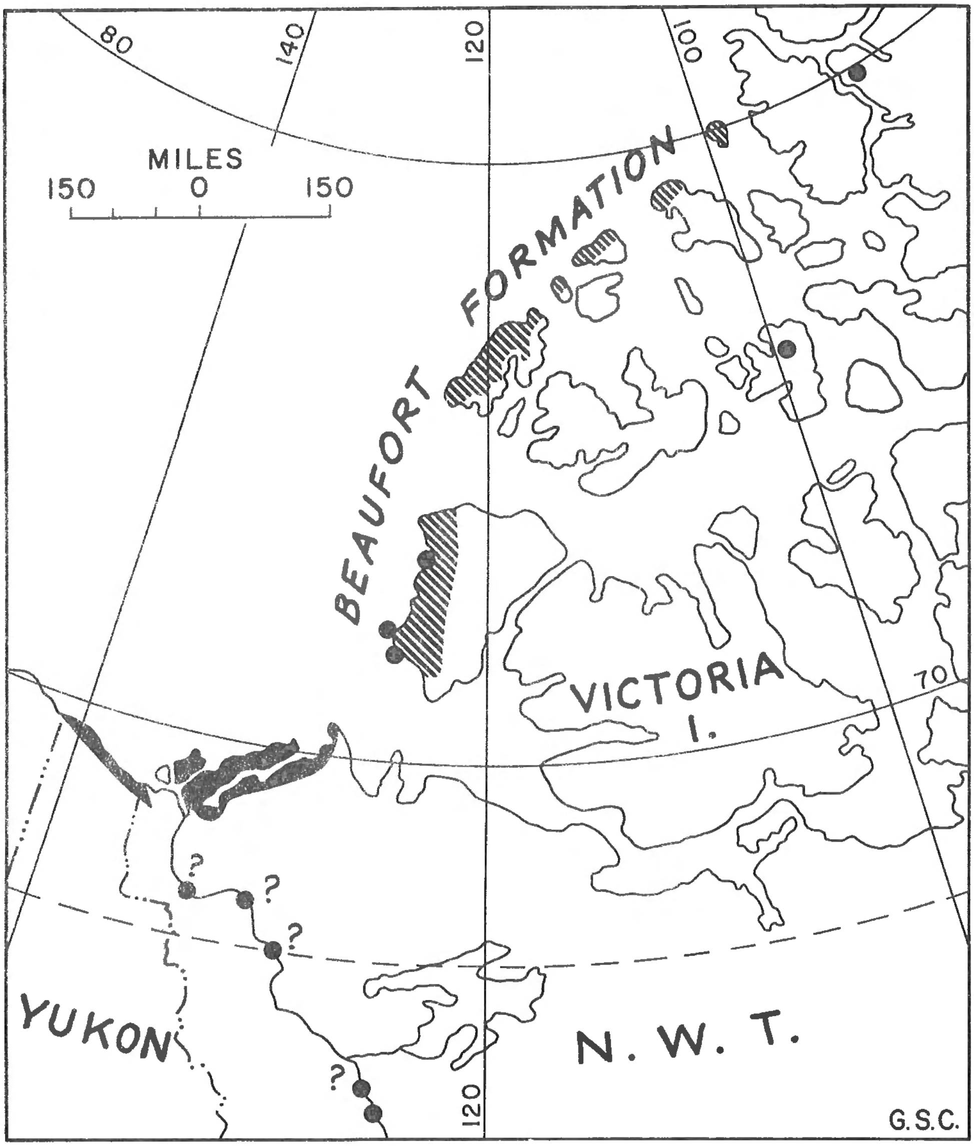

Figure 2. Interglacial and pre-glacial deposits.

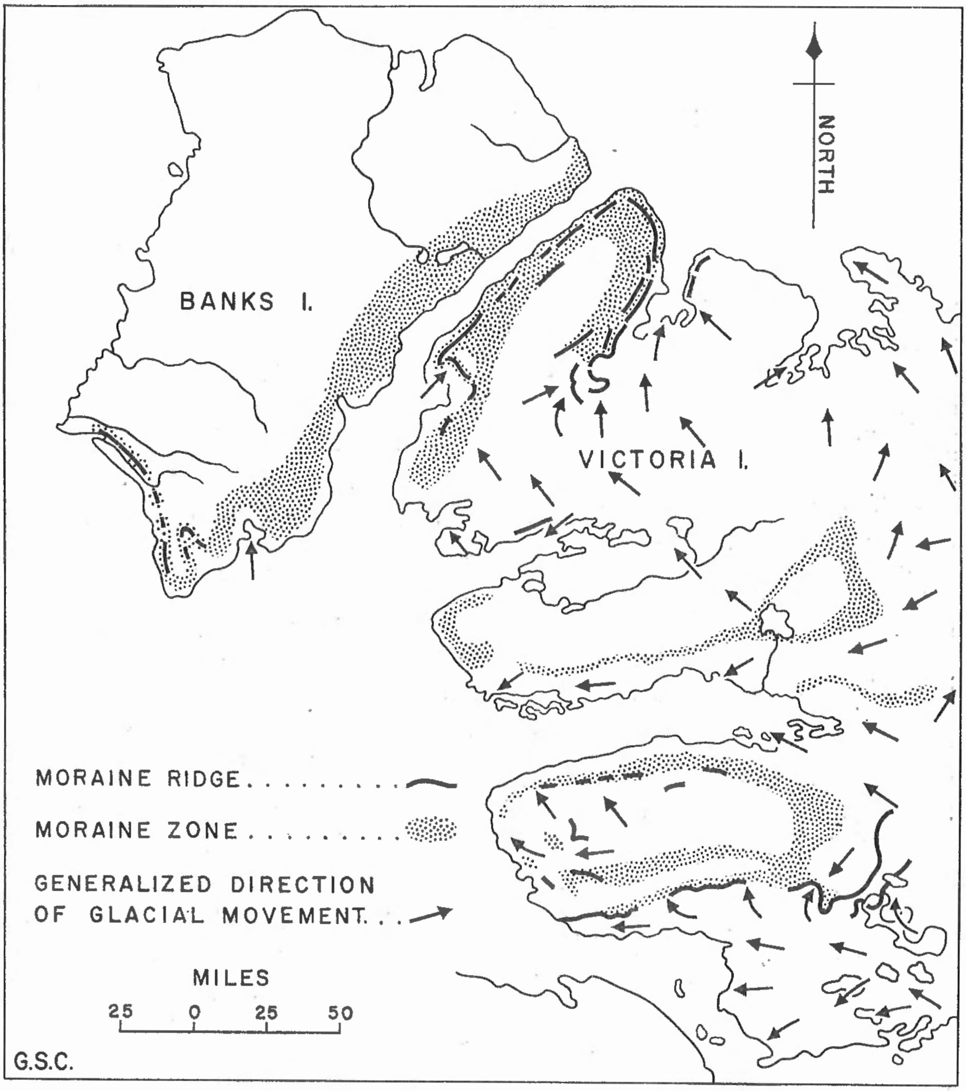

Figure 3. Principal moraines, Victoria and Banks Islands.

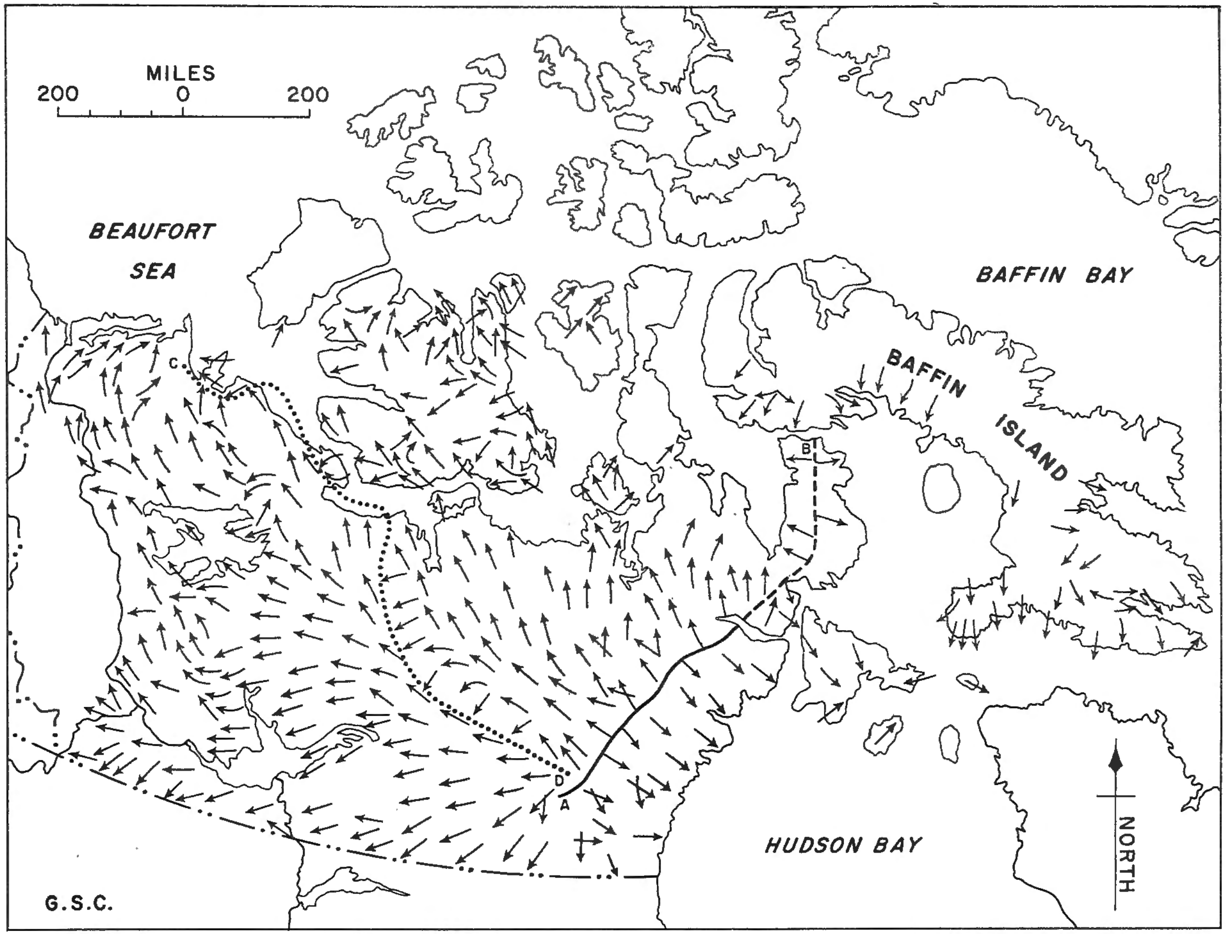

Figure 4. Generalized directions of glacial flow in the Northwest Territories. A-B, Keewatin ice divide; C-D, discontinuity in flow pattern.

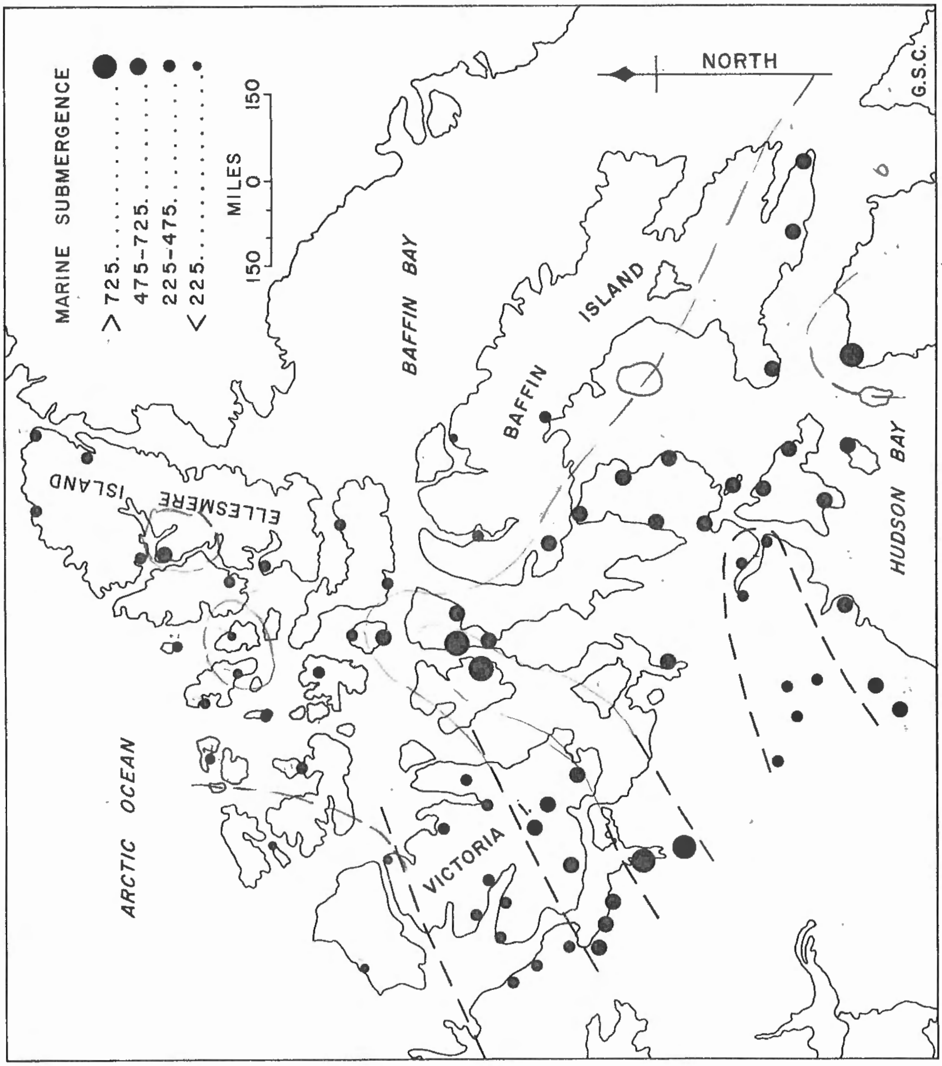

Figure 5. Generalized elevations of highest recorded marine features.

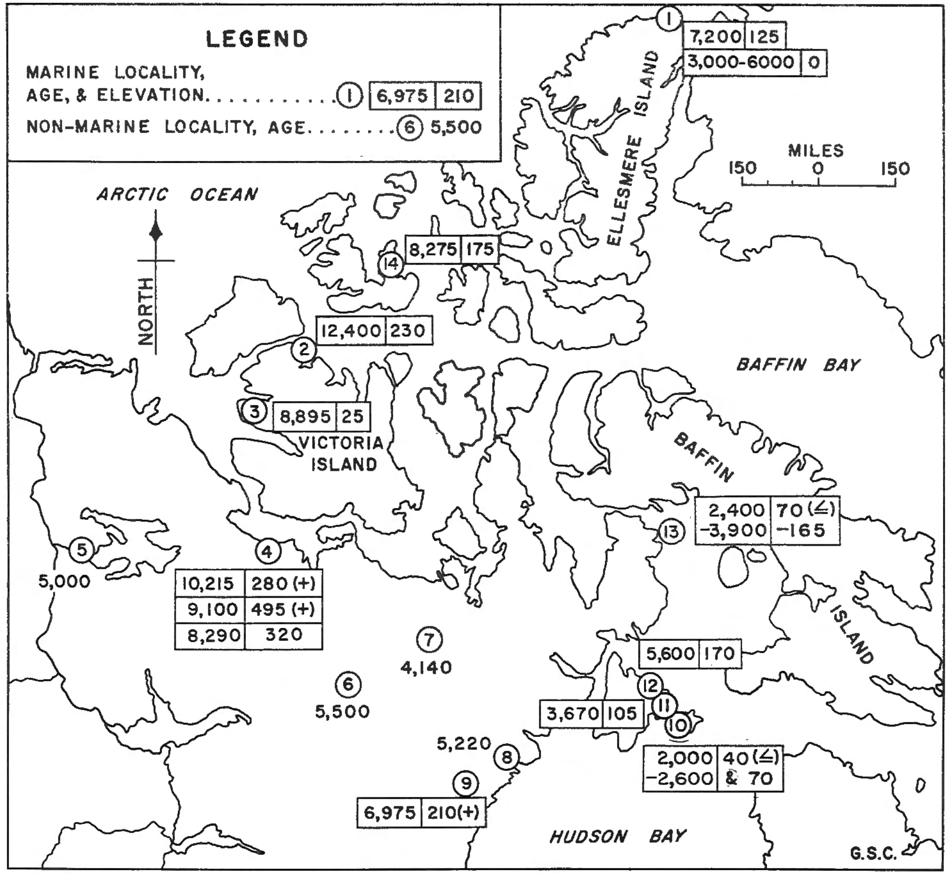

Figure 6. Radiocarbon ages of post-glacial materials. (Dates are in years before present. Elevations are in feet. Elevations are followed by (+) where the sea-level to which the date applies was significantly higher than the sample site, and by (≦) in the case of archaeological samples where sea-level may have been lower than the site.)

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