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PRELIMINARY ACCOUNT OF THE GLACIAL HISTORY OF BATHURST ISLAND, ARCTIC ARCHIPELAGO

(Report and figure)

Weston Blake, Jr.

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ABSTRACT

Bathurst Island, in the central part of the Arctic Archipelago, lacks the prominent glacial landforms such as drumlins and eskers that characterize certain more southerly islands. It does not appear to have been overridden by the continental North American (Laurentide) ice sheet during the last glaciation (classical Wisconsin). Nonetheless Bathurst Island bears undoubted evidence of glaciation in the form of till, erratics, and meltwater channels. Erratics, commonly of a quartzose sandstone that outcrops on the island, are widespread and occur at altitudes up to at least 1,100 feet (335 m), far above the limit of marine submergence. Other important features indicating glaciation are: striae, lakes in bedrock basins, areas of streamlined drift, end moraines, and areas of dead-ice topography.

Apparently most of these features are related to locally-centred ice cap(s), but the occurrence of till containing shells above the marine limit at several localities along the east coast may possibly be the result of a glacier tongue in the straits having impinged upon the island.

The rapid uplift that has taken place in postglacial time, as determined by radiocarbon dating of marine shells from the raised beaches, is believed to have resulted from glacial rebound. Thus the last glaciation of Bathurst Island is inferred to have taken place during Wisconsin time. The altitude of the marine limit is close to 300 feet (90 m) along the east-central and southeast coasts, but it reaches 400 feet (120 m) in the long inlets that indent the north coast, suggesting that the ice may have been thicker in the latter area.

The radiocarbon dates on marine shells, plus one on peat, also indicate that much of the island was ice-free by 9,000 years ago. Since then peat deposits have formed in many localities, but in two places buried peats are more than 35,000 years old, suggesting that they are interglacial, or possibly interstadial, in age.

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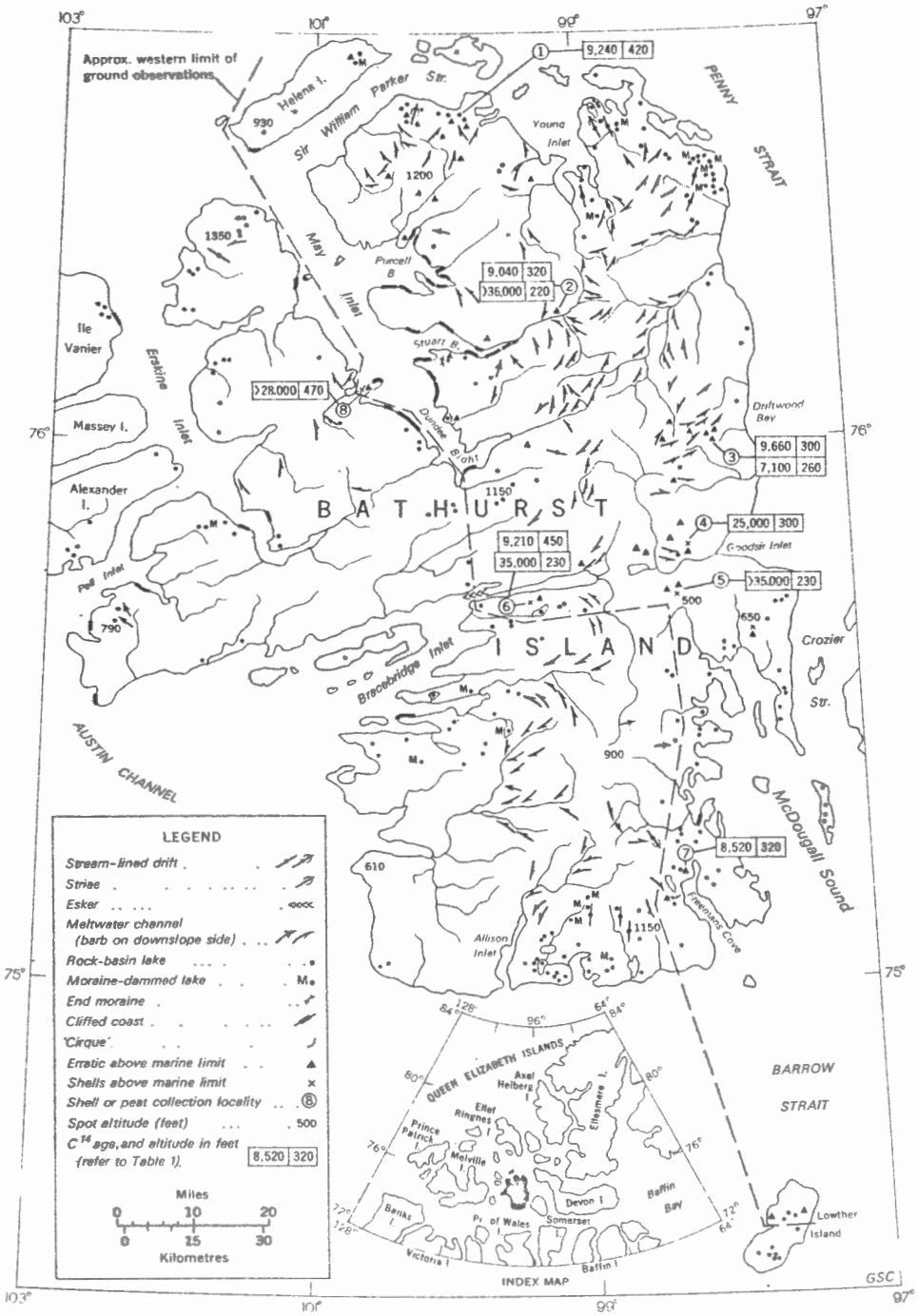

Figure 1. Glacial features and location of radiocarbon-dated samples on Bathurst Island

PRELIMINARY ACCOUNT OF THE GLACIAL HISTORY OF BATHURST ISLAND, ARCTIC ARCHIPELAGO[1]

INTRODUCTION

Bathurst Island is situated in the central part of the Canadian Arctic Archipelago. Its south coast lies along the 75th parallel, and the North Magnetic Pole is close to the southwest corner of the island. It was first explored by various Franklin search expeditions in the 1850's, and the geological observations made then were virtually the only ones available until a century later. Reconnaissance bedrock mapping of the island was carried out in 1955 during 'Operation Franklin' (Fortier et al., 1963), and in connection with this work observations on the surficial deposits were made in a few areas. However, until 1963 no systematic investigations of glacial geology had been made. The radiocarbon dates reported here are the first available, and they represent the initial step in establishing an absolute chronology of Pleistocene events on Bathurst Island.

Except for some minor basic intrusive rocks near the southeast corner (McNair, 1961, p. 425), Bathurst Island is composed of folded sedimentary rocks - limestone, dolomite, shale, and sandstone - ranging in age from Ordovician to Devonian (Fortier et al., 1963, pp. 576-632; Kerr, 1964, pp. 4-5). The island is irregular in outline, with deeply indented coasts. Although its maximum dimensions are roughly 95 miles (155 km) east-west by 120 miles (195 km) north-south, no point is more than 15 miles (25 km) from the sea. The northern part is dominantly a ridged upland, the south is more plateau-like (Roots, 1963, pp. 580-584). The highest point, in the northwestern peninsula, is only 1,350 feet (410 m) above sea-level, but in places relief is as much as 600-1,000 feet (200-300 m). No ice caps or valley glaciers exist today on the island. Snowbanks that persist for many years are common, however, and possibly a few of the snow and ice bodies in nivation hollows on the northwestern peninsula are, in fact, miniature glaciers.

EVIDENCE FOR GLACIATION

The air photographs show that glacial landforms such as drumlins, crag-and-tail hills, and eskers, which characterize certain more southerly islands (e.g., King William, Victoria, Stefansson, and Prince of Wales) in the Arctic Archipelago are absent or scarce on Bathurst Island. Actively moving, thick ice of the continental

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[1] This paper is an interim report after the 1963 field season's work on Bathurst Island. It appears, with minor additions, as it was prepared for presentation at the 20th International Geographical Congress, London, England, July-August 1964.

North American (Laurentide) ice sheet did not, apparently, override this island, at least during the classical Wisconsin. However, the following features indicate that the island has been glaciated (Fig. 1).

Patches of drift are distributed widely, and in a few places the drift shows slightly streamlined forms, which are unrelated to the underlying folded bedrock. The elongated hills are so subdued that it is difficult to recognize them on the ground, but they can have been made only by moving ice; they indicate the trend, though in general not the direction, of ice motion.

Erratic boulders are widespread at all altitudes from sea-level to 1,100 feet (335 m), the highest point visited. Only those above the limit of former marine action are of interest here; those at lower levels can have been rafted by sea ice or icebergs, and the distribution of certain low-level erratics suggests that ice-rafting has indeed played a part. Most common are erratics of a quartzose sandstone that outcrops widely on the island, but because of the repetition of strata in the folded structures these erratics do not indicate the direction in which the ice moved.

Marine mollusc shells, worn and fragmented, occur in a thin till cover on several east-coast hilltops, as well as east of Bracebridge Inlet and west of May Inlet. In each case the shells occur above the highest visible beaches. Dates of approximately 25,000, more than 28,000, and about 35,000 years (two fractions dated) have been obtained on these high-level shells (see Figure 1 and Table I). The molluscs lived before the last regional glacial advance, and they have probably been transported to their present positions by glacier action. The high-level shells along the east coast could have been transported by a glacier tongue that flowed in the straits to the east and impinged upon the island, but in each locality there is land low enough to have once been covered by the sea to the west also, so that the shells may have been transported by ice flowing off Bathurst Island. Certainly the presence of high-level shells east of Bracebridge Inlet and west of May Inlet can best be explained as a result of local glacier action.

Eskers. In the west-central part of the island a sinuous, sandy, east-west oriented and 50-foot (15 m)-high ridge at sea-level is believed to be an esker. A few other east-west ridges in the same area may be eskers too, although all have been modified by wave action.

End moraines. At two coastal localities ridges around the ends of lakes are interpreted as end moraines. These ridges have been modified by wave action also, as both localities are within 50 feet (15 m) of sea-level, but the material in the ridges is basically till.

Dead-ice topography exists in some areas where till, often bouldery, is concentrated. A number of such areas contain kettle holes, some of them occupied by ponds.

Lakes and ponds in basins excavated in bedrock are common (cf. Hobbs, 1945, pp. 549-550; Jenness, 1952a, p. 250; 1952b, p. 945), especially in a zone near the coasts, although Bathurst Island is not characterized by the profusion of lakes so typical of the Canadian Shield. It is difficult to explain the existence of these basins in all types of bedrock except as a result of excavation by glacier ice. Their concentration near the coasts is natural as there ice flow would be channeled by pre-existing valleys, resulting in more intense erosion.

Striated bedrock surfaces, overlain in places by till, occur in one northern valley. Rounding of the striated sandstone suggests ice motion toward the north. Farther north the same valley is occupied by a rock-basin lake more than 1.5 miles (2 km) long. Striae were not found elsewhere, probably in part because the sedimentary rocks weather so rapidly.

Cliffed coasts. The present configuration of the island suggests that the topography, despite recent emergence, is still drowned and is basically the result of stream erosion. Some structural control, though not faulting, may be necessary to explain the parallelism of the inlets indenting the north coast (see Kerr, 1964, p. 5), but the cliffs, which occur primarily along these inlets, are probably glacially eroded.

Cirque-like basins, with northerly exposures and in places containing lakes, are present in northern Bathurst Island. Most of them are low enough in altitude that the incursion of marine waters would have prevented the existence of cirque glaciers in post-glacial time, and undisturbed raised beaches indicate that glaciers have not re-formed in these basins since their emergence from the sea. Thus the formation of the 'cirques' must pre-date the last major glaciation.

Meltwater channels are the most abundant feature indicating that ice once covered the island. Some are individual ice-marginal channels cutting across bedrock ridges where no streams now flow; elsewhere groups of lateral drainage channels occupy the sides of valleys where glacier tongues once lay.

Raised beaches, indicating that land uplift has exceeded the eustatic rise of sea-level, are widespread. In the absence of evidence indicating faulting or uplift due to other causes, and in view of the normal postglacial age of the beaches, uplift is taken to be a result of isostatic recovery of the crust upon thinning and disappearance of glacial ice. Radiocarbon dates are listed in the accompanying table.

Table I

Radiocarbon Dates

Locality No. (Fig. 1)	Dating No.	Altitude of sample: feet (m)	Dated material	Age (years before 1950)
1	GSC-182	420 (130)	Hiatella arctica (L.)	9,240 ± 160
2	GSC-164	320 (100)	Hiatella arctica (L.)	9,040 ± 170
3	GSC-179	300 (90)	pelecypod fragments	9,660 ± 210
7	GSC-191	320 (100)	Mya truncata L.	8,520 ± 150
6	GSC-180	450 (140)	basal organic debris	9,210 ± 170
3	GSC-201	260 (80)	surface peat	7,100 ± 140
4	GSC-166	300 (90)	pelecypod fragments	25,000 ± 500
8	GSC-223	470 (145)	pelecypod fragments	>28,000
6	GSC-212	475 (145)	Hiatella arctica (L.)	
			20-53% fraction	33,100 +1,300 -1,100
			inner 47% fraction	35,900 +1,400 -1,200
2	GSC-165	220 (65)	peat beneath post-glacial marine silt	>36,000
5	GSC-178	230 (70)	peat beneath till	>35,000

DISCUSSION

The dates on marine shells indicate that much of the island was ice-free by 9,000 years ago. Support for this conclusion is provided by a date of 9,200 years on the basal organic matter in a

9 foot (2.75 m)-long core of frozen peat from west-central Bathurst Island.[1] Peat deposits that are apparently of postglacial age are widespread, and the one other absolute age available indicates that peat at the surface of a deposit more than 5 feet (1.5 m) thick at an east coast locality is 7,100 years old.

Of particular interest is the fact that the basal, 9,200 year-old peat in the core contains seeds of Ranunculus trichophyllus var. eradicatus and leaves of Vaccinium uliginosum and Salix pseudopolaris. None of these plants are present in the collections of present-day vegetation made by the writer during 1963; i.e., buttercups are represented by Ranunculus sabinei and R. sulphureus, no bilberry (Vaccinium uliginosum) was found, and willow is represented only by Salix arctica. As far as is known at the present time, the three plants found in the basal peat are restricted, now, to either the more southerly or easterly islands in the archipelago (e.g., see Porsild, 1957; Savile, 1959; Savile, 1961; Beschel, 1961), suggesting that conditions on Bathurst Island may have been more favourable to plant growth and peat formation in early postglacial time than they are today.

The record of events earlier in Pleistocene time is limited. Two samples of peat, one beneath postglacial marine silt (see McLaren, 1963, pp. 616-619, for a description of this site; also Prest, 1957, pp. 457-458; Craig and Fyles, 1960, p. 4), the other beneath till believed to correspond to the till containing the 25,000 year-old shells, are more than 35,000 years old (Table I). As yet we do not know when these peat deposits formed; the last interglacial would seem to be the most likely time, but an early Wisconsin interstadial is also a possibility. Nor do we know, assuming that the 'old' dates on shells are correct[2], what glacial events, if any, took place in early Wisconsin time.

In summary, the evidence presented indicates that much, if not all, of Bathurst Island was covered by glacial ice during the classical Wisconsin. It does not seem unreasonable to assume that some areas may have been deglaciated by 10,000 years ago, and extensive areas were ice-free by 9,000 B.P. Local glacier action seems sufficient to account for the high-level shells in till, but the possibility exists that a glacier tongue in the straits impinged upon the east coast of the island. If such a tongue existed it was probably part of the continental North American (Laurentide) ice sheet. How

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[1] The upper 10 inches (25 cm) of peat were unfrozen, and a block of this material was removed to expose a hard surface on which to core. The coring was carried out with a hand-operated, SIPRE-type ice-corer manufactured by AB Stålsvets, Sollentuna, Sweden. Progress was slow until the cutting teeth of tool steel that had been used in 1962 in the Yukon (Hughes and Terasmae, 1963, pp. 270-272) were replaced by "Carboloy" cutting teeth.

[2] In spite of some of them being finite dates, the values given are probably minimum ages for the shells (cf. Olsson and Blake, 1961-1962, pp. 47-56).

far the ice cap(s) on Bathurst Island extended beyond the present coasts is unknown, but possibly at some stage the local ice was part of a larger ice cap, which may have covered much of the inter-island area to the north that is now sea. One point to be considered is the altitude of the marine limit. This rarely exceeds 300 feet (90 m) along the east-central and southeast coasts of the island, but in the inlets indenting the north coast it is close to 400 feet (120 m); in fact, at the northern tip of the island postglacial shells were found at 430 feet (130 m). Thus, the altitude of the marine limit increases toward the northwest, rather than decreasing in that direction as suggested by Farrand and Gajda (1962). This variation may mean that the ice was thickest over the northern part of Bathurst Island.

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