

GLACIOLOGICAL RESEARCH IN THE CANADIAN ARCTIC†

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THE glaciers of the Canadian Arctic are amongst the least known of the northern hemisphere. From the earliest surveys, however, it was clear that they contain numerous features of exceptional interest to the glaciologist. The ice assumes many different forms including glacier caps, highland glaciers grading into vast areas of transection glaciers, valley, cirque, and piedmont forms, and finally some unique shelf ice. It is believed that all this ice has non-temperate geophysical characteristics (Ahlmann, 1948, pp. 66-7) and that, therefore, there is a wide range of types to study, intermediate between Greenland's polar inland ice, and the temperate ice of Iceland and Norway. The regimen of the glaciers in the Canadian Arctic is apparently healthier than those studied by Ahlmann around the North Atlantic.

The highland rim of northeast arctic Canada was probably the source region from which the Wisconsin Laurentide Ice sheet expanded to cover an area nearly as large as Antarctica in eastern and central North America. At the close of the Wisconsin age the ice disappeared in southern areas and the lowlands of the north, but has persisted as remnants on Baffin, Bylot, Devon, Ellesmere, and Axel Heiberg islands to the present day (Flint, 1943).

The glacierized area under consideration (Fig. 1) extends about 1,600 miles and occupies an estimated area of 50,000 square miles. Northern Labrador is omitted as only small glacierettes exist today. Ellesmere Island, completely photographed from the air, but still to be mapped in detail, has more than half the total ice for the region. It is found in four distinct areas, Grant, Grinnell, Ellesmere proper, and North Lincoln (or Sverdrup), called "quarters" here for convenience.

Glaciology is a youthful subject and it is not surprising that the early explorers made no real glaciological studies. However, a careful perusal of their stories reveals some information, particularly on the change in extent of the ice areas. For example, M'Clintock describes the position of the front of a Bylot Island glacier, Kaparoktalik, in 1858. He says that it was 300 or 400 yards broad, 150 to 200 feet high and extended across the valley to within 300 yards of the shore, and that an Eskimo village lay between the snout and the sea (M'Clintock, 1859, p. 157). Today the glacier is still within about 300 yards of the shore.

The Nares expedition of 1875-76 (Nares, 1878), Greely seven years later (1886), Peary (1910), and Sverdrup (1904), all contribute pieces of like

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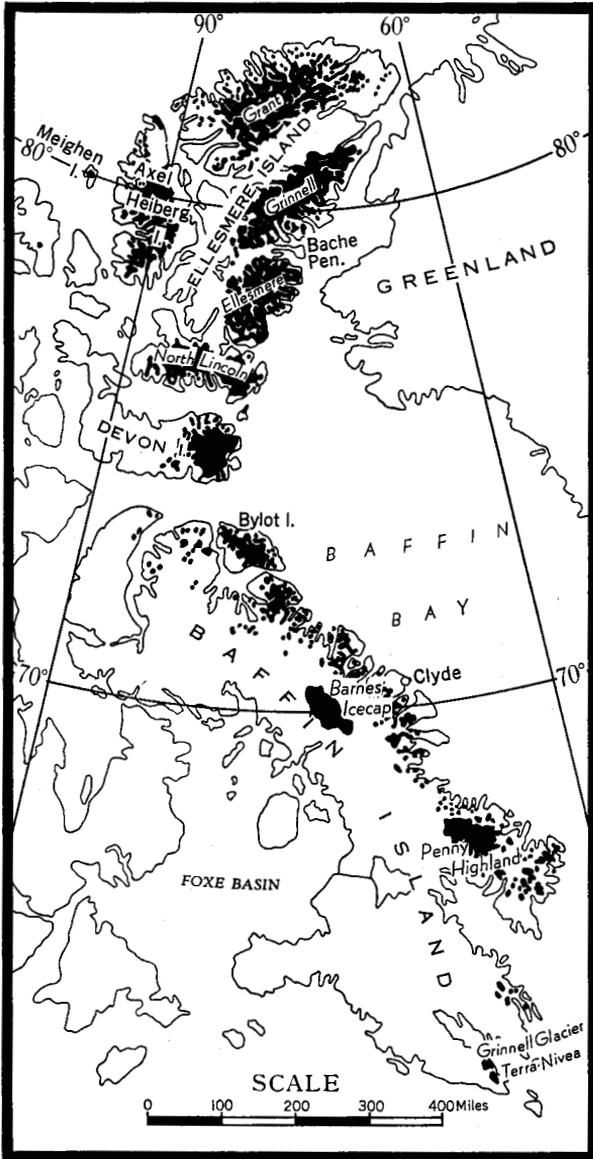


Fig. 1. Glaciers and ice caps in the Canadian eastern Arctic.

information, as do the accounts of Bernier in the early years of this century, and the Danish Fifth Thule expedition of the 1920's. A report by Eskimo to Mathiassen (Mathiassen, 1933) of this latter expedition, resulted in the first appearance of the Barnes Icecap on the map, and it was actually first viewed by members of the Wordie expedition in 1934 (Wordie, 1935, p. 311).

Prior to 1939 there were several small scale expeditions to the Canadian Arctic which, though not primarily glaciological, contributed to our knowledge of the ice regions. Wright, surveying the east coast of the Ellesmere "quarter", described the condition of highland ice, with frequent nunataks and rock ridges,

and considerable stretches of piedmont ice reaching the sea (Wright, 1940). Bentham farther south, in the North Lincoln (or Sverdrup) "quarter", was more coast-bound but he noted some interesting features: the glaciers seemed stationary or were retreating slightly; and surprisingly, he saw no erratics more than 5 miles from existing ice, and no evidence of former complete glaciation of the area at all (Bentham, 1941, p. 44). In 1932 a detachment of Royal Canadian Mounted Police found an advancing glacier had blocked the normal sledge route across Ellesmere between Bache Peninsula and Bay Fiord (*Polar Record*, 1934, p. 122).

The writer visited Bylot Island in the summer of 1939, and crossed the island by dog team in June. This is an area of transection glaciers and highland ice, previously marked as a single smooth ice cap, with many nunatak mountain peaks and ridges protruding, and piedmont glaciers extending on to the plains in the north and southwest. Moraines are weakly developed, and the glacier which I descended on the crossing to Bathurst Bay had no terminal moraine, only slight median moraine, and vegetation growing up to its front at 260 feet above sea level (Fig. 2). On June 4 at a height of 3,150 feet there was 3 feet of winter's snow on glacier ice; the firn line was obviously considerably higher on this southwest-flowing glacier than elsewhere. However, on the summit, a peak about 6,100 feet high, a small rock knob projected through a snow dome. The view from this peak shows the characteristics of interior Bylot Island (Fig. 3).

Scientists have made observations on the Grinnel Glacier in southern Baffin Island over a period of years. The majority were made by members of MacMillan's expeditions (Buerger, 1938; Roy, 1937, 1938). Their brief visits told us little, except that it was frequently foggy and that the large ice cap first described by Hall (1865, pp. 519-20) was really two small ones. Wynne-Edwards visited the area in summer 1937 and reached 2,750 feet on the ice dome in better weather than most of the other scientists (Wynne-Edwards, 1939).

Real glaciological work in the Canadian Arctic did not begin until after 1945; it has comprised the two Arctic Institute expeditions of 1950 and 1953 (Baird, 1952; Baird and others, 1953), further work on the Grinnell ice cap by Mercer¹ and the investigations of Hattersley-Smith and others on the Ellesmere Island expeditions to the north Ellesmere ice shelf in 1953 and 1954 (Hattersley-Smith and others, 1955).

In 1950 the Arctic Institute sent a strong expedition to Baffin Island to study the Clyde area, about 70°N., and the Barnes Icecap. This ice cap is quite exceptional; there can be few other ice masses of similar area, 2,300 square miles, which are surrounded by bare ground of very moderate altitude and relief and are quite unconnected with any highland source of supply (Fig. 4). The nourishment of the Barnes Icecap is also unusual; there was no developed firn, but there was (during the ablation season of 1950) an equilibrium line where the accumulation of superimposed ice on the cold surface balanced the ablation (Baird, Ward, and Orvig, 1952, p. 8). I am unable to

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Fig. 2. Bylot Island east glacier.



Fig. 3. Bylot Island, view northwest from summit, 6,100 feet.



Photo: M. H. W. Ritchie

Fig. 4. Southeast edge of Barnes Icecap.

explain the existence of this ice cap other than to suggest that it is a surviving relic from the Wisconsin ice sheet, which has persisted through the climatic optimum.

The small ice cap on Meighen Island, the farthest northwest in the Canadian Arctic, is probably similar to the Barnes in its nourishment and low ground environs, but it is probably much thinner and certainly smaller. A glaciological expedition to this island would be very interesting; it might also provide information on Krüger and Bjare who disappeared in 1930 trying to reach Meighen Island (*Polar Record*, 1934, p. 122).

In 1953 the Arctic Institute organized a second expedition to Baffin Island to examine the Penny Highland ice cap on the Cumberland Peninsula. The expedition was mainly glaciological: a station, A1, was established at 6,725 feet on the highest dome of ice, overtopped only by some slightly higher marginal mountains. This station was above the firn line which, however, was surprisingly high at 5,000 feet, although an equilibrium line was noted at about 4,600 feet. At the summit station, summer melting took place for brief periods measurable in hours only (61 the longest) (Orvig, 1954, p. 276), producing ice layers in the firn of irregular thickness and frequency. It was

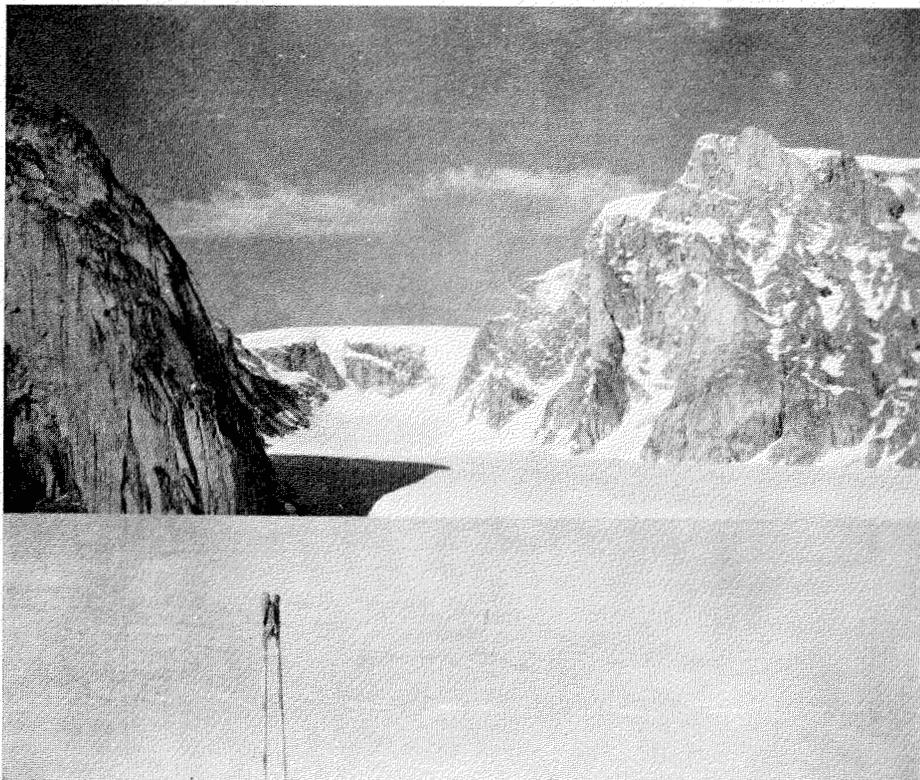


Photo: W. H. Ward

Fig. 5. Head of Highway Glacier seen from "Concordiaplatz". Ice cap dome in the distance.

not possible to date annual layers (apart from the previous year's), but it appears that the accumulation, reduced by windsweep on the dome, is about 18 inches of water, and the temperature of the ice at depth of zero amplitude was -13°C . This was only 2°C colder than the corresponding temperature on the Barnes Icecap, although the station on the latter was nearly 4,000 feet lower. Vertical homogeneity of temperature is apparently a common feature in the Canadian Arctic, although an exception was found in Highway Glacier, an outlet glacier of the Penny Icecap, where temperatures of about -6°C were measured.

Highway Glacier, which was selected for study (Fig. 5), is connected with the main highland ice, including the dome on which the summit station was placed, but it actually draws its nourishment from a rather limited basin. From station A2 at the head of Highway Glacier at a height of 6,300 feet, down to the terminus at less than 1,300 feet, ablation and temperature stations were maintained and seismic work was carried out to determine ice thickness (Röthlisberger, 1955). At A2 refraction shooting was employed which gave wave velocities in the ice showing good agreement with those found by Holtzscherer in Greenland (Joset and Holtzscherer, 1953); they showed a

considerable accumulation of firn (about 165 feet according to the wave velocities) with an ice layer, possibly representing an abnormally warm summer, at 41 feet. The bedrock was 820 feet below the surface of the ice. At this station, situated in a col surrounded by smooth hills, accumulation was obviously greater than on the windswept dome at the summit. Later, the seismic equipment was moved down to the "Concordiaplatz", at about 3,300 feet, where three ice streams join to form the lower part of Highway Glacier; detailed reflection shooting was done here, and several sections were also made lower down.

The results show that there is no rock floor basin as one might expect at such a junction, and as is present at the Aletsch Glacier's Concordiaplatz. The sections showed regular U-shapes, with a maximum ice thickness of about 1,300 feet. This junction is undoubtedly on one of the major structural rock trends where the bedrock would likely be shattered and susceptible to the supposed erosive powers of the glaciers. All three glaciers steepen markedly above the "platz", and the ice is moving relatively quickly. At the camp site, on a lateral moraine, crevasses were groaning, and opening and closing.

A fairly reliable longitudinal profile was obtained of the lower part of the glacier; it grades very smoothly down to Pangnirtung Pass, the slope of the floor being about 1.3° and that of the surface about 3.3° . Refraction measurements were made on the thinning ice where the glacier swings east into the pass; the ice appeared to be about 500 feet thick and was underlain by supposed moraine, 90 feet thick if the material was unfrozen, or 141 feet thick if frozen (Röthlisberger, 1955, p. 546).

This area of Baffin Island has very impressive scenery, and the evolution of the landscape and the rocks on which it developed were studied by our geomorphologists and geologists. A summary of some of their findings, which pertain to the matter of this paper follows.

The old peneplain surface, now visible in the accordant summits of the mountains, was at some time in the late Tertiary, strongly uplifted, tilted, and faulted. According to Tanner (1944, p. 126) at this period in Labrador "strong tectonic movements occurred with unbounded faulting, down- and up-warping, some folding and basaltic eruption". This had also occurred in the Cumberland Peninsula. Kidd traced for 55 miles along the coast of Davis Strait, a narrow belt of basaltic flows now situated at 1,000 to over 3,000 feet above sea level (Baird and others, 1953, p. 241). Underneath were beds of agglomerate and tuff which he believes were formed beneath the sea. This indicates an uplift here of at least 1,000 feet. The uplift was much greater in the centre of the peninsula (Fig. 6) and although no very great faults were seen, Kidd observes that these granitic-type, Precambrian rocks appear to fail when under great stress in the "dry" state rather than flow plastically.

The writer agrees with Thompson (1954) that a great deal of block faulting occurred as the plateau heaved up and in the resulting rifts and crush zones local rivers began rapidly to erode valleys. The ice caps which formed on the high plateau remnants during the Pleistocene gave some protec-



Photo: W. H. Ward

Fig. 6. Mt. Asgard, 6,596 feet, seen from Mt. Battle, 4,420 feet. Turner Glacier to the right.

tion against erosion while rivers continued for a time to carve the valleys. Later ice streams occupied and further modified these valleys. Presuming that the interglacials, if they occurred here, were as warm or warmer than the present climate, it seems likely that rivers have occupied the large valleys, such as Pagnirtung Pass, for at least as long as have glaciers and Thompson gives them the credit for most of the excavation rather than the moving ice. The writer believes to a certain extent in the protection hypothesis for ice and the carving of valleys and fiords as due not only to ice, but also to water action in rifts formed by yielding of the bedrock to vertical forces.

Research work has also been carried out on the ice shelf off the northernmost coast of Ellesmere Island, a most interesting glaciological phenomenon. The ice islands in the Arctic Ocean, which have been broken off from this shelf are readily recognizable from their size and shape and have yielded much information on the currents and the slow clockwise eddy that exists here (Koenig and others, 1952). One of the islands was occupied by the U.S. Air Force for twenty-five consecutive months, and studies were made by scientists from the Air Force Cambridge Research Center. They found among other things rock piles on the surface and more than fifty layers of dirt

and mud in a 52-foot hole (Crary and others, 1952). The ice shelf, which is about 10 miles wide west of Cape Columbia (Hattersley-Smith and others, 1955, p. 4) occupies fiord mouths and open coast. It has a peculiar rolled surface not yet satisfactorily explained, which was commented upon by early travellers such as Aldrich and Peary. A similar formation, the "Sikussak" has been described in northwest Greenland by Koch (1926, p. 100). Debenham (1954) has speculated on the method of origin of the ice shelf and many of his ideas were proved well founded by Hattersley-Smith. They agree that the shelf grows from below by freezing sea water rather than from above, as normal ablation seems to remove all the annual snow cover plus a few inches of ice (24 inches were lost in 1954 which was an unusually warm summer in the Canadian Arctic). But the shelf is up to 150 feet thick, the same as ice island T3, and water depths of over 980 feet were found off the northwest edge. Thus Debenham's gently shelving coast is not valid, nor his idea of the ice being more or less continuously aground. A narrow tide crack was present between ice and land which could, by freezing each winter, produce lateral pressure to account for the surface rolls in fiords. The writer, however, does not agree that the Arctic Ocean pack ice forms the compressive agency on the open coast sections. For one thing, the hole in the shelf left by the break off of an island in 1946 is now covered by 20 feet of ice, but *unrolled* ice. Perhaps the rolls are due to some differential snow-drift ablation. Similar features have appeared on Ellesmere Island lakes (Montgomery, 1952, p. 187) and the melting pattern seen by the writer on temporary sea ice in Clyde Fiord, is suggestive.

One great problem is why the ice should be so thick here compared with the open sea pack. Presumably it needs calm water, preferably stagnant, and low temperatures. The water is kept calm by the pack offshore. The mean annual air temperature is very low (around -20°C) and the thick ice at depth will presumably be about this temperature and able to extract heat from the sea below. But why should the new growth fill up the hole in the shelf edge, at nearly 3 feet a year? Hattersley-Smith believes that the shelf has formed since the climatic optimum a few thousand years ago (Hattersley-Smith and others, 1955, p. 23). The dating of driftwood found in the ice by the Carbon 14 method should give further information.

In southern Baffin Island Mercer studied the Grinnell ice cap and, briefly, its southern neighbour, Terra Nivea, in 1952 and 1953. On each occasion his stay was much less than the full ablation season, but the two successive summers showed interestingly dissimilar conditions. The Grinnell has eight outlet glaciers in the north and east, four of which reach Frobisher Bay. All of these are in retreat or stationary, but on the south a broad lobe which terminates at about 1,000 feet above sea level was advancing over mature heath vegetation. Mercer found superimposed ice and firn on the summit domes which nowhere rise above 2,860 feet (Mercer, 1954).

He investigated particularly the raised strand lines in the region and believes the highest stands at 1,425 feet. It is always hard to be certain that such strand lines are old sea levels. Such an elevation could have occurred

since the ice load was removed. Mercer believes that during the Pleistocene this area must have been starved of precipitation. Today, however, precipitation is high in this area and there are very low summer temperatures and much summer fog.

Returning to the general picture and budgetary state of the Canadian arctic glaciers. Recession is marked in Pangnirtung Pass, 200 to 300 yards on one tributary glacier between 1925 and 1948, but little since then. It is also marked in Frobisher Bay, with the exception noted above; it is, however, very limited on the Barnes Icecap and the contiguous coastal zone, and also in Bylot Island and southern Ellesmere. In the Grant Land "quarter" recession appears to be appreciable, possibly due to lack of precipitation rather than to increased ablation.

From the slender evidence available there appears to be great variation in the height of the firn line instead of any uniform poleward decline. It stands at only 2,150 feet on the Frobisher glaciers, but is about 5,000 feet on Cumberland Peninsula and probably not far below that on the other Baffin coastal mountains and on Bylot Island. The equilibrium line was at 2,600 feet on the inland Barnes Icecap. Much more work is necessary before good reasons for this variability can be given. It should be remembered that temperature lapse rates are unusual in the Arctic where deep winter inversions are frequent; however, ablation season drop in temperature with altitude is fairly normal and annual mean temperatures at sea level are between -8°C in Frobisher Bay to -20°C on Ellesmere Island (Rae, 1951, p. 41).

Examining Flint's hypothesis of the Baffin-Labrador origin of the American ice sheet (Flint, 1943), all the evidence so far points to a large and prolonged uplift of the Baffin rim, on which ice might have grown sufficiently to spill westward and then by its own nourishment momentum grow still farther. The writer finds it hard to account for the moist air masses sufficient to keep this momentum on the growing southwest edge, but given their presence, a growth from this uplifted region seems feasible. Retreat by stages with persisting ice domes distributed around in Hudson Bay, Ungava, and probably last of all in Foxe Basin, again seems likely. More detailed work comparable with the Scandinavian work on retreat is required.

Bird has already done some useful work towards this in Keewatin where he finds lake levels in the Dubawnt River basin up to 800 feet, presumably dammed by Hudson Bay ice to the east, and finally an old sea level 360 feet above that of today, representing the moment when this Hudson Bay ice retreated sufficiently to let in the ocean (Bird, 1951, pp. 22-3). Foxe Basin is now a shallow area still probably undergoing upward recovery. On the low limestone islands now emerging from the sea there must have been one of the last ice centres. In 1950 Goldthwait found strong evidence of southwest-northeast ice movement in the area south of the Barnes Icecap, a movement as if from such a source region (Goldthwait, 1951, p. 568). The writer finds the Barnes itself difficult to explain except as the last relic of a final ice dome, comparable to the relics in the late Pleistocene time in the Swedish lake district, at present slowly migrating northeastwards, in approximate



Fig. 7. Corrie and edge of ice cap seen from "Concordiaplatz".

equilibrium with present climate, and maintaining itself by its own great cold. One little side problem—could the lack of musk ox remains in Baffin Island be due to the very recent lingering of the Foxe Basin-Baffin ice, and the chance that the musk ox and its enemy, man, arrived at the same time?

The Canadian Arctic region is an excellent area for examining problems of the erosive and protective powers of high polar glaciers and of the origin of fiords. The evidence from Baffin shows well the protective power of small ice caps and highland ice sheltering the mountain and plateau tops, while erosive forces attack their flanks and the valley floors (Fig. 7). The power of glacier melt streams to down-cut strongly in a region where uplift is continuing, can be seen and compared with the down-cutting and valley-widening powers of the ice streams themselves (Chamberlin and Chamberlin, 1911).

The peculiar S-shaped fiords of the region show the type of tearing and faulting that might be produced by the uplift and stretching of these hard Precambrian rocks. Once again it seems that rifting and water erosion in the rifts were as important (Gregory, 1913) as down-cutting by the ice, which undoubtedly filled them deeply.

Little is yet known of the bathymetry of the Canadian fiords. Baffin Bay itself seems to be a downfaulted depression alongside the upfaulted coast line of Baffin Island. We do already know, however, that on the opposite coast the west Greenland fiords are rather curiously shallow in comparison with some of the great Norwegian and western American depths (Dunbar, 1951, pp. 20-7), despite the great thickness of ice inland of them and the rapid movement of outflowing ice streams.

Altogether this is a region of splendid glaciological opportunity, a region of great and violent forces and a source of factual evidence for the great controversies on the subject of the origin of the ice sheets and of their effects on the terrain.

References

- Ahlmann, H. W.:son. 1948. 'Glaciological research on the North Atlantic coasts'. *R. G. S. Research Ser.* No. 1, 83 pp.
- Baird, P. D. 1952. "The Baffin Island expedition, 1950". *Geogr. J.* Vol. 118, pp. 267-79.
- Baird, P. D., W. H. Ward, and S. Orvig. 1952. "The glaciological studies of the Baffin Island expedition, 1950". *J. Glaciol.* Vol. 2, pp. 342-55.
- Baird, P. D. and others. 1953. "Baffin Island expedition, 1953: a preliminary field report". *Arctic*, Vol. 6, pp. 227-51.
- Bentham, R. 1941. "Structure and glaciers of southern Ellesmere Island". *Geogr. J.* Vol. 97, pp. 36-45.
- Bird, J. B. 1951. "The physiography of the middle and lower Thelon Basins". *Geogr. Bull.* No. 1, pp. 1-29.
- Buerger, M. J. 1938. "Spectacular Frobisher Bay". *Can. Geogr. J.* Vol. 17, pp. 3-17.
- Chamberlin, T. C. and R. T. Chamberlin. 1911. "Certain phases of glacial erosion". *J. Geol.* Vol. 19, pp. 193-216.
- Crary, A. P., R. D. Cotell, and T. F. Sexton. 1952. "Preliminary report on scientific work on 'Fletcher's ice island', T3". *Arctic*, Vol. 5, pp. 211-233.
- Debenham, F. 1954. "The ice islands of the Arctic: a hypothesis". *Geogr. Rev.* Vol. 44, pp. 495-507.
- Dunbar, M. J. 1951. "Eastern arctic waters". *Fish. Research Bd. Can., Bull.* 88, 131 pp.
- Flint, R. F. 1943. "Growth of North American ice sheet during the Wisconsin age". *Geol. Soc. Amer. Bull.* Vol. 54, pp. 325-62.
- Gregory, J. W. 1913. 'The nature and origin of fiords'. London: xvi + 542 pp.
- Goldthwait, R. P. 1951. "Development of end moraines in east-central Baffin Island". *J. Geol.* Vol. 59, pp. 567-77.
- Greely, A. W. 1886. 'Three years of arctic service. An account of the Lady Franklin Bay expedition of 1881-84 . . .'. New York: Vol. 1, xxv + 428 pp.; Vol. 2, xii + 444 pp.
- Hall, C. F. 1865. 'Arctic researches and life among the esquimaux . . .'. New York: 595 pp.
- Hattersley-Smith, G. and others. 1955. "Northern Ellesmere Island, 1953 and 1954". *Arctic*, Vol. 8, pp. 3-36.
- Joset, A. and J. J. Holtzschere. 1953. "Etudes des vitesses de propagation des ondes sismiques sur l'inlandsis du Groenland". *Ann. Geophys.* Vol. 9, pp. 329-44.
- Koch, L. 1926. "Ice cap and sea ice in north Greenland". *Geogr. Rev.* Vol. 16, pp. 98-107.
- Koenig, L. S., K. R. Greenaway, Moira Dunbar, and G. Hattersley-Smith. 1952. "Arctic ice islands". *Arctic*, Vol. 5, pp. 67-103.
- McClintock, F. L. 1859. 'The voyage of the "Fox" in the arctic seas . . .'. London: xxvii + 403 pp.
- Mathiassen, T. 1933. 'Contributions to the geography of Baffin Land and Melville Peninsula'. *Rep. Fifth Thule Exped. 1921-24.* Copenhagen: Vol. 1, No. 3, 102 pp.

- Mercer, J. H. 1954. 'The physiography and glaciology of southernmost Baffin Island'. McGill University, unpub. Ph.D. thesis.
- Montgomery, Margaret R. 1952. "Further notes on ice islands in the Canadian Arctic". *Arctic*, Vol. 5, pp. 183-7.
- Nares, Sir G. S. 1878. 'Narrative of a voyage to the polar sea during 1875-6 in H.M. ships "Alert" and "Discovery"'. London: Vol. 1, xl + 395 pp.; Vol. 2, viii + 378 pp.
- Orvig, S. 1954. "Glacial-meteorological observations on icecaps in Baffin Island". *Geogr. Ann.* Vol. 36, pp. 193-324.
- Peary, R. E. 1910. 'The north pole, its discovery in 1909 under the auspices of the Peary Arctic Club, by Robert E. Peary'. New York: xxxii + 373 pp.
- [*Polar Record*]. 1934. "Krüger search expeditions, 1932". *Polar Record*, No. 8, pp. 121-9.
- Rae, R. W. 1951. 'Climate of the Canadian Arctic Archipelago'. Canada Department of Transport. Toronto: 90 pp.
- Röthlisberger, H. 1955. "Studies in glacier physics on the Penny Icecap, Baffin Island 1953. Part 3: Seismic sounding". *J. Glaciol.* Vol. 2, No. 18, pp. 539-52.
- Roy, S. K. 1937. "The Grinnell Icecap". *Field Mus. Nat. Hist., Chicago. Pub.; Geol. Ser.* Vol. 7, No. 1, pp. 1-19.
1938. "Additional notes on the Grinnell Icecap". *Field Mus. Nat. Hist., Chicago. Pub.; Geol. Ser.* Vol. 7, No. 4, pp. 59-69.
- Sverdrup, O. 1904. 'New land. Four years in the arctic regions'. London: Vol. 1, xvi + 496 pp.; Vol. 2, xii + 504 pp.
- Tanner, V. 1944. 'Outlines of the geography, life, and customs of Newfoundland-Labrador (the eastern part of the Labrador peninsula)'. *Acta Geographica Fenniae*, Vol. 8, No. 1, 909 pp.
- Thompson, H. R. 1954. 'Pangnirtung Pass, Baffin Island: An exploratory regional geomorphology'. McGill University, unpub. Ph.D. thesis.
- Wordie, J. M. 1935. "An expedition to Melville Bay and north-east Baffin Land". *Geogr. J.* Vol. 86, pp. 297-316.
- Wright, J. 1940. "South-east Ellesmere Island". *Geogr. J.* Vol. 95, pp. 278-91.
- Wynne-Edwards, V. C. 1939. "Some factors in the isolation of rare Alpine plants". *Trans. Roy. Soc. Can.* Vol. 33, Ser. III, Sect. V, pp. 35-42.