Short Papers and Notes

ICE-PUSH RAMPARTS IN THE GEORGE RIVER BASIN, LABRADOR-UNGAVA

Introduction

Field work in the Whitegull Lake area in the Upper George River basin was carried out while the author was based at the McGill Sub-Arctic Research Laboratory, beginning in the last week of the partial open water season in July 1963. Observations of ice-push ramparts, still at that time partially covered with lake ice, were made then and later in the season. These ramparts are of significance when evaluating both modern and fossil lake shore development and when estimating the ice conditions that prevailed in past times.

Ice-push ramparts, under different names[1,2,3] have been studied in various parts of the world since 1822, which is the earliest reference in Charlesworth[4]. Subsequently two main genetically-determined types of ice-push rampart have been recognized.

First, there are those features due to the push of lake ice expanding after a sufficiently sudden temperature rise. Although Hobbs[5] attributes lake ramparts in general to this process it has only been demonstrated on lakes with a comparatively thin ice cover[6,7] through which temperature change can penetrate rapidly. It is the process invoked for lake ramparts in mid-temperate latitudes[8,9]. Far more important in northern regions is the process whereby lake ice rafts ashore, sometimes climbing tens of feet after strong and persistent winds during the partial open-water season [10,11]. Ramparts of this type have been observed at Cambridge Bay, Victoria Island[9] and at a number of other places including Baffin Island[12].

To these types of rampart may be added the minor features formed by small candling ice-chunks being driven ashore by waves late in the partial open water season. In this case only material up to shingle size is moved significantly and the resultant ridges are often destroyed or modified by wave action later in the summer. Proglacial lakes with calving ice fronts may have their shorelines modified by icebergs although the effect would be expected to vary with the size of the iceberg and the slope of the shore.

The rarity of ice-push ramparts in Labrador-Ungava is possibly a reflection of their restricted environments. In view of this and of the following discussion it is worth while quoting Hubbard's description of ice-push ramparts at Lake Michikamau[13].

> "... a peculiar mound of rocks along the edge of the water which proved to be characteristic of the whole shoreline of the lake. The rocks had been pushed out by the ice and formed a sort of wall while over the wall moss and willow grew — back of these were swamps."

Ice-push features in the Whitegull Lake Area.

Lakes Whitegull and Michikamau are both large exposed lakes with, on the whole, gently sloping shores. Whitegull Lake is largely the result of damming by the esker which cuts it off from Leif Lake to the north so that it spills into the George River more directly over rapids to the west. Eskers were traced by echo sounder across the lake in several places; sometimes eskers near the water surface had been scoured by ice-push to form islands.

The features are best described with reference to Figs. 1 and 2. The first shows a rampart built of material dredged from shoalwater around a bedrock island. Being made of smaller sized cobbles it is freshly distributed and rests at high angles, in excess of 35° in some cases. Boulders rest precariously on the crest of the ridge. The second example is made up of much larger boulders and is a more stable feature.

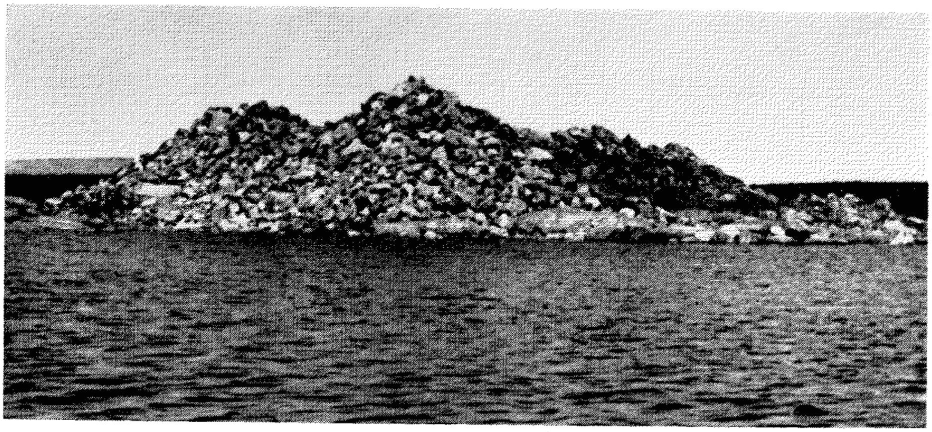

Fig. 1. Ice-push rampart, 12-15 ft. high, on a low bedrock island near the entrance to the northwest arm of Whitegull Lake

Both these types of rampart are best developed on islands beyond extensive shoals. Ramparts in general are found on islands and around the shores of Whitegull, Raude and the larger of the neighbouring lakes. In many cases they are merely lines of boulders. The size of the ramparts would appear to be governed by the availability of boulders. These, as far as lake ice is concerned, are more plentiful on gently shelving shores, locations which tend to protect the ramparts from severe wave action during the summer.

In some cases the rampart blocks were some three or four feet high and the bent and shattered trees found near many ramparts suggested a considerable and prolonged pressure. It was first thought that lake ice expansion before breakup might yield this effect. But, as it was later pointed out [14], the temperature changes necessary for the expansion do not significantly penetrate snow-covered ice which is as thick as that found during the winter in northern Canada. Unfortunately the field party arrived too late in the partial open water season to observe lake ice rafting ashore although many ramparts still carried lake ice (Fig. 3). However, the writer saw the process the following summer in Baffin Island. Once this kind of ice rafting has been seen in action there can be no doubt in the observer's mind that the necessary force can be exerted. It is well documented[11] but not seen often because the partial open water season is very short.

If ice rafting is held responsible for ice-push features in the Whitegull area it might be expected that their disposition would relate to the prevailing wind regime. This is not the case in the Whitegull Lake area except on Raude Lake south of Whitegull Lake. This lack of lee-shore orientation is probably due to the fact that the partial open water season in Labrador-Ungava is only about 13 days[15].

It is interesting to note that when seen from a canoe, some of the lake ramparts might be taken for raised shorelines. Thus it may be that the "raised shorelines" described by Low[16] at Lake Michikamau are ice-push ramparts. In 1960 Ives[17] pointed out that Low's raised shorelines were an enigma in the light of data on the deglaciation of the George River Basin to the north. This view is supported by recent work[18]. Certainly an intricate ice dam would be necessary to hold up a body of water 35 ft. above present lake level in the Michikamau locality[19]. Whether or not ice-push ramparts can be as high as 35 ft. can only be checked by field work. The problem is a puzzling one: raised shorelines in Labrador-Ungava are usually apparent from air-photos but none has been identified on the photographs of the Michikamau area.

Raised shorelines and the action of lake ice.

Before the ice conditions which prevailed on the former pro-glacial Naskaupi lakes[17] of Labrador-Ungava can be inferred from the presence or absence of fossil ice-push features on their raised shorelines, it is necessary to assess the relative importance of the various ice pushing agents and the variables which determine their effectiveness at any one place. Perhaps one should first turn to some modern though smaller counterparts of the Naskaupi Lakes, for example the pro-glacial lakes around the north edge of the Barnes Ice Cap in Baffin Island[20]. Ward[12] has shown that the six week ice-free period is insufficient for wave action to destroy boulder ramparts. However, in Baffin Island many of the higher lakes rarely become totally free of ice and there may be small ice floes dampening the effect of the waves on exposed shores until the onset of winter. The presence of some lake-ice throughout the summer near the Baffin Island ice caps is especially noticeable during poor summers[21] such as those of 1950 and 1963.

By analogy it might be suggested that the partial open water and open water conditions on the Naskaupi pro-glacial lakes were often restricted to the eastern sections away from the ice-barriers. Thus Matthew[20] favours the pan ice floe to the iceberg as the operative agent at that time and invokes a short partial open-water season to explain the lack of them as fossil features today. Alternatively, a long open water season might be responsible. Yet with the probably longer season prevailing today, ice push features do not seem to suffer, though it is true that most are protected by gently shelving shores in contrast to the steep hillslopes upon which the Naskaupi shorelines developed. It would seem that the analogy between conditions at the time of the Naskaupi lakes and the modern pro-glacial lakes of Baffin Island cannot be carried far until more evidence is available from which to infer the state of the Laurentide ice in Naskaupi times. Certainly a definite open-water period of some kind seems likely because the shorelines, both erosional and depositional, are so well developed.

Indeed, Ives[17] in his evaluation of conditions on the eastern shorelines of the Naskaupi lakes does not mention lake ice. He points to the lack of evidence of iceberg action on shorelines and suggests the existence of a distant ice dam and a western boundary comprising much dry land, rather than a pro-glacial lake relatively free from bergs. Thus a genuine open water season, such as occurs in Labrador-Ungava at present, is implied. As Derbyshire[22] has demonstrated, the climate of late glacial times was probably not

Fig. 2. Rampart in esker shoalwater between the northeast and northwest arms of Whitegull Lake.

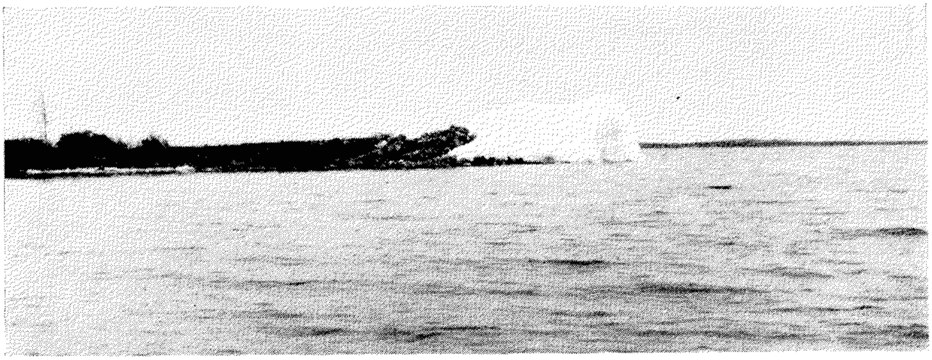

Fig. 3. Eastern shore of Whitegull Lake late June 1963. Rafted ice carried by rampart stands some 15 ft. above the lake.

very different from that of the present. Whether this inferred condition at the time of final wastage can be applied to the climate of Naskaupi times is very doubtful. The distinct lake phase demands a major still-stand of the ice sheet which must have been sufficiently massive to dam considerable quantities of water.

The steep hillsides of much of the eastern shores of the Naskaupi lakes[17] and N2 in particular, contrast with the gently-shelving, though not too shallow[9], shore regions of the modern lakes of the plateau where ice push ramparts have been reported. This may account for the absence of ice-push features on the fossil shoreline remnants. Thus the steep hillsides provided an optimum condition for the formation of wave cut platforms, but were generally too steep for ice push ramparts to be well formed. Detritus is not easily dredged from non-shelving shores and such ramparts as might have been built were not out of the reach of wave action. In contrast, the gently sloping shores in the lower areas of more plentiful drift, such as the present Whitegull and Michikamau lake regions, have provided conditions favourable to the formation of ice push ramparts.

The critical relationships between all the factors mentioned above can only be tested by field work. Suitable lakes demand observation from before breakup until its completion. Future work should also include the mapping of these features over wide areas and the gathering of further data on the length of the partial open water season in different localities.

The factors involved in wind controlled ice-push in lakes are not very different(*cum grano salis*) from those in the sea and the two situations are not discussed separately by Washburn[9]. However, the different conditions on the shores of some arctic beaches, where ice may be forced ashore at any time of the year[23], and around the lakes of the Labrador-Ungava plateau, where ice push would seem to be confined to the short partial open water season, must clearly be borne in mind during these future investigations.

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ACCESS TO MEIGHEN ISLAND, N.W.T.*

Meighen Island (80° N. 100° W) lies in the centre of the northwest edge of the Queen Elizabeth Islands (Fig. 1) and its northern coast fronts on the Arctic Ocean. Sverdrup and Peary Channels, which separate Meighen Island from Axel Heiberg and Ellef Ringnes Islands, are generally filled with ice during the summer months. The season of maximum open water occurs in early September, but at this time floes of heavy polar ice move into the channels. The island is one of those never visited by surface vessels, and is very likely to retain this distinction for some time as it is of little economic interest compared with other equally inaccessible islands in the western Queen Elizabeth group.

* Based on meteorological observations recorded over three field seasons by K. C. Arnold, Canada Department of Mines and Technical Surveys, as part of the Geographical Branch's contribution to the Polar Continental Shelf Project.