ARCTIC
VOL. 35, NO. 4 (DECEMBER 1982) P. 542-544

The Ward Hunt Ice Shelf, Spring 1982

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ABSTRACT. In order to improve the understanding of arctic ice shelf evolution, ice coring and water sampling were undertaken and observations made on the Ward Hunt Ice Shelf and surrounding area during spring 1982. A total of 74 m of 7.6 cm diameter ice core was obtained from seven locations including Ward Hunt Ice Shelf, Ayles Fiord and Milne Ice Shelf. Water sampling of Lake 'A' and Disraeli Fiord indicated that these water bodies remain stratified. Observations of ice conditions between Ward Hunt Island and Cape Evans revealed the following: accretion of multi-year ice along the front of Ward Hunt and Milne Ice Shelf; grounding and/or loss of approximately 40 km^2 of ice shelf near Cape Discovery; possible development of rolls in multi-year ice in Ayles Fiord; and evidence of former ice tongues in Milne Fiord.

RÉSUMÉ. Des carottes de glace et des échantillons d'eau ont été prélevés sur le plateau de glace Ward Hunt et dans la région adjacente durant le printemps de 1982, en vue d'augmenter nos connaissances sur l'évolution du plateau de glace de l'Arctique. Des carottes de glace de 76 m en longueur et de 7.6 cm de diamètre ont été prises à sept endroits, y compris le plateau de glace Ward Hunt, le fiord Ayles et le plateau de glace Milne. L'échantillonnage de l'eau du lac "A" et du fiord Disraeli a indiqué que ces corps d'eau demeurent stratifiés. L'étude de la condition des glaces entre l'île Ward Hunt et le cap Evans a signalé les observations suivantes: une accrétion de vieille glace de long du devant des plateaux de glace Ward Hunt et Milne; l'échouement et/ou la perte de quelque 40 km^2 du plateau de glace près du cap de la Découverte; le développement possible d'une surface houleuse sur la vieille glace du fiord Ayles; et des preuves de la présence antérieure de langues de glace flottante dans le fiord Milne.

Traduit pour le journal par Maurice Guibord.

INTRODUCTION

The Ward Hunt Ice Shelf, northern Ellesmere Island, is a known source of ice islands tens of metres in thickness and tens of square kilometres in area. Such ice masses are the result of periodic calving at the ice front where they are released into the Arctic Ocean. Renewed interest in the ice shelves of northern Ellesmere Island has arisen because of the increase in oil exploration in the Beaufort Sea. Any large ice mass, ice island or pack ice, presents a considerable threat to the exploration for and the extraction and removal of oil. The nature of possible future ice islands can be studied at source: the ice shelves of northern Ellesmere Island. This paper outlines the work undertaken and some of the observations made on the Ward Hunt Ice Shelf and surrounding area in spring 1982.

THE EXPEDITION

The author and assistant Harold Serson departed from Resolute Bay for Tanquary Fiord in a Twin Otter aircraft on 23 April 1982. Two days were spent at the former Defence Research Board camp at the head of Tanquary Fiord from which food and equipment were obtained. At 2:00 A.M. on 26 April the expedition, complete with equipment and stores, arrived on Ward Hunt Ice Shelf. Base camp was established at 83°05′N, 76°36′W (Fig. 1) where a party from Defence Research Establishment Pacific (DREP) had built a hut, set up a camp and marked a runway earlier in April.

The first two weeks were spent obtaining ice cores in three different locations, WH/01, WH/02 and WH/03 (Fig. 1; Table 1). All cores were hand-drilled with a SIPRE corer. Observations along the front of the ice shelf were also made during this period. On 9 May we departed for Lake 'A', Disraeli Fiord and Ward Hunt Island (Fig. 1), and returned to base camp on 17 May. On 14 May the accumulation stake networks on the ice shelf and ice rise were measured (Fig. 1). After a few days of strong winds and poor visibility we left base camp on 21 May, travelling westward to Ayles Fiord and Milne Fiord, returning to base camp via Taconite Inlet (Fig. 1) on 25 May. After obtaining cores from two more locations, WH/06 and WH/07, the 1982 program was completed on 30 May. After seven days of poor weather which prevented the aircraft from landing we returned to Resolute Bay on 7 June.

All travel in the area was by Bombardier twin-track Alpine Ski-Doo, each towing a *komatik* loaded with survival and scientific equipment.

OBSERVATIONS

An area of the Ward Hunt Ice Shelf at approximately 83°05′N, 76°55′W was seen to have grounded since the last ice survey by H. Serson in spring 1980. Large fractures contained sediment which may have been forced up through the cracks under pressure as the ice settled on the rock or sediment below the shelf. The buckled and fractured

TABLE 1. Depth and location of cores

Core	Location	Depth (m)
WH/01	Base camp, ridge	26.19
WH/02	Trough by ice rise	5.18
WH/03	Ice rise	20.00
WH/04	Ayles Fiord, ridge	2.11
WH/05	Milne Fiord, ridge	3.15
WH/06	Basement ice, 5 km W of Rambow Hill	3.49
WH/07	Trough, E of Base Camp	13.79

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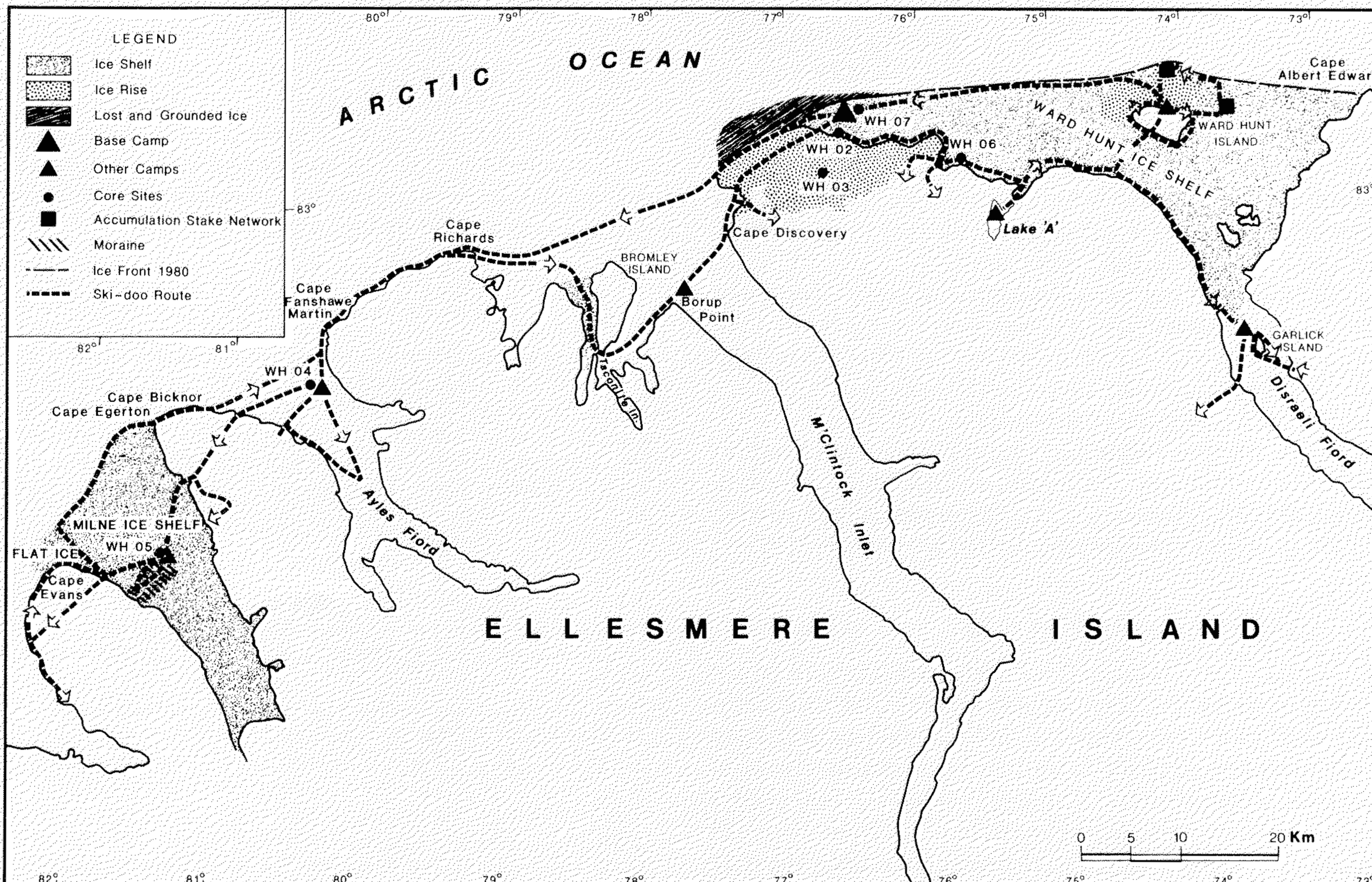

FIG. 1. Map of northern Ellesmere Island showing Ward Hunt Ice Shelf, Ayles Fiord and Milne Ice Shelf.

grounded ice suggested that further changes in the ice front had occurred since 1980. Using a portable Marconi Satellite Navigation system, John Torleifsson of DREP established the new position of the ice front at the western end of the shelf (Fig. 1). This shows 35-40 km^2 of shelf to have been removed or grounded.

The whole of the ice front is characterized by a line of first-year pressure ridges, some of which reach a height of 5 m. Along the greater part of the ice-shelf front east of base camp the ice is hummocky, consisting of a series of pressure ridges which decrease in height and angularity, and presumably increase in age, away from the ice front. The distance between large, first-year pressure ridges and smaller (0.75-1.0 m) multi-year ridges is as much as 400 m, suggesting that the ice shelf grows in part, at least for short periods of time, by accretion of multi-year ice at the outer edge. However, this multi-year ice is likely to be short-lived in some cases. A short distance northeast of base camp a 500-m stretch of multi-year ice was severely distorted by fracturing and buckling. The much-weakened ice might well be sheared off the ice front as the pack ice breaks up and begins to move.

Hattersley-Smith (1967) observed only scattered ice islands and ice slivers in Ayles Fiord. Travelling across Ayles Fiord on 21-22 May we saw no evidence of the well-developed rolls illustrated by Hattersley-Smith (1955:12). The area of ice around the camp and WH/04 core site appeared to have rolls of low amplitude (up to 1 m) and long wavelength, though the low relief made it difficult to discern the topography. The ice shelf may have been replaced by thickening multi-year ice which is now developing rolls in a manner similar to the Markham Bay re-entrant (Ragle *et al.*, 1964). In order to compare the ice in Ayles Fiord with known ice-shelf ice, a short core (WH/04) was obtained (Table 1.)

The surface of Milne Ice Shelf (Fig. 1) is distinguished by rolling topography and also by three curious radial features. It is unclear whether these features are drainage channels, cracks, or sutures within the shelf. Another feature, never previously noted though clearly visible on air photographs, is the presence of moraines which run into the shelf from the lateral margins of glaciers adjacent to the western edge of the ice shelf (Fig. 1). Though the glaciers are no longer contiguous with the ice shelf, if the hummocks and conical mounds of rock are lateral or medial moraines then it is possible that at some time in the past this and other glaciers formed ice tongues in Milne Fiord. Such glaciers might have coalesced to form an ice shelf, acted as nuclei for further shelf growth, or some combination of these. The effect of glaciers on Ward Hunt Ice Shelf is described by Hattersley-Smith (1955).

On 24 May, while travelling from the camp to the outer edge of Milne Ice Shelf, we observed a considerable change in the shelf surface. Unlike the rest of the shelf with its rolling topography, the 2-3 km wide area north of one of the fractures is completely flat except for drifted snow and sastrugi (Fig. 1: "flat ice"). Radio-echo sounding has shown this piece of ice to have quite different reflections, suggesting that the ice here is unlike that in the rest of the ice shelf (Bradley Prager, U.B.C., pers. comm.).

On 10 May, using a Knudsen bottle together with three reversing thermometers, we took water samples and temperatures to a depth of 68 m in Lake 'A' (the lake is 69 m deep). The temperature and salinity profiles obtained are almost identical to those of Hattersley-Smith *et al.* (1970). Lake 'A' remains stable and stratified. The sampling procedure was repeated at a station on Disraeli Fiord a little north of Garlick Island (Fig. 1). The profiles obtained here in 390 m of water are very similar to those of Keys (1978).

FURTHER WORK

The ice cores obtained from northern Ellesmere Island will be analyzed in order to identify ice types and structures, ice shelf growth mechanisms and ice shelf origin. They will be subjected to ice fabrics and ice density, chemical and stable radio-isotope analysis (^{18}O and ^{3}H). Few chemical and isotope investigations of ice cores from the north coast of Ellesmere Island have been undertaken, the only published results being those of Lyons *et al.* (1971). It is believed that the results of comprehensive chemical and isotope work will improve the understanding of the structure, behaviour and origin of Ward Hunt Ice Shelf. Further chemical and isotope analyses are being undertaken on the water samples from Lake 'A' and Disraeli Fiord. Further investigations on the ice shelves of northern Ellesmere Island are planned for spring 1983.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the financial and logistic support of the following organizations: The Arctic Institute of North America; Dome Petroleum Ltd.; Gulf Canada Ltd.; Supply and Services Canada, Contract No. 065B, 97708-1-0993; and the Polar Continental Shelf Project. My grateful thanks to Harold Serson for his invaluable assistance.

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