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The Regime of the Ward Hunt Ice Shelf and of the Ice in the Mouth of Nansen Sound, Ellesmere Island

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We have analyzed the results of ten years' (1958-68) record of accumulation and ablation on the ice rise and of three years' (1965-68) on the ice shelf (Hattersley-Smith and Serson, 1970). The net mass balances on the ice rise for the three years 1962-65 were positive, while the net mass balances for the other years on both ice rise and ice shelf were all negative. It should be noted that the records for the ice shelf started only in 1965-66 and refer to surface mass balance; we do not know what is happening at the underside, although in 1969 John Lyons drilled a 47 m hole through the ice shelf between Ward Hunt Island and the mainland and found sea- rather than fresh-water beneath. Although there is no close correlation between seasonal melt and mean monthly temperatures at Alert, fairly small deviations from mean summer temperatures appear to determine whether the mass balance is positive or negative. For this reason neither ice rise nor ice shelf should be considered as a relic glacial feature. I am suggesting on rather meagre evidence that we may be seeing the beginning of a period of renewed surface build-up following a period of net surface ablation at least since 1906. We know this date of 1906 because we found on the surface of the ice shelf in 1954 the debris of one of Peary's camp sites. Because of the warm summer of 1954 when the net ablation was more than 600 mm water, we tended to assume that the ice shelf was thinning rapidly as a result of climatic warming and that this was the reason for massive calving in recent decades (Hattersley-Smith, 1963a). I think the calving should much more appropriately be related to unusual tidal effects, and this Dr. Gerald Holdsworth (Glaciology Subdivision, DEMR) is doing. To summarize, the ice about Ward Hunt Island has been ablating at an average rate of only about 60 mm/yr since 1958, and has actually been accreting at the rate of about 30 mm/yr since 1963.

We might expect the recent cooler summers off the northern Ellesmere coast to have caused build-up of fast ice, as for example in Nansen Sound. A good deal of information has been obtained by Defense Research Board field parties on sea-ice thicknesses in the Nansen Sound fiord system. First-year ice, which covers most of the inner parts of the fiords, ranges in thickness from 2 to 2.5 m in Tanquary and Greely Fiords. However in Hare and Otto Fiords, first-year ice as thin as 1.15 m has been found, the reason for which is not clear. Second-year ice, which is frequently found in the outer parts of the fiords and is common in Nansen Sound, reaches thicknesses of 3 to 3.5 m. Much older sea ice is frequently encountered, and near the mouth of Nansen Sound is a plug of old ice that is believed not to have broken up for at least 8 years. From field work in May 1969, Mr. Harold Serson of the Defence Research Board concluded that the ice plug reaches thicknesses of 6 m or more over an area of about 1,000 km^2, from a line joining Lands Lokk to Cape Stallworthy southward to a line running southwestward from Emma Fiord. It forms an impenetrable barrier to any surface ship, and also blocks the drift of ice from the Arctic Ocean. For these reasons we plan detailed investigations of this interesting feature, which we suggest relates to cooler summers since 1962, following the warmer post-1925 period that was recognized in our earlier glaciological work on the central ice cap of Ellesmere Island (Hattersley-Smith, 1963b). It seems that ice conditions at the north end of Nansen Sound are reverting to what they were in the early part of the century, when travellers reported very old unbroken floes. Indeed R. E. Peary's description in 1906 suggests that an ice shelf covered the mouth of Nansen Sound at that time. In contrast, in 1932, Corporal H. W. Stallworthy's party encountered new pressure ice over this area.

It is clear therefore that present climatic conditions off the north coast of Ellesmere Island allow very thick developments of landfast sea ice to form up to the point where they may be regarded as incipient ice shelves. On the one hand, the ice plug in Nansen Sound could improve ice conditions in the channel to the south by barring the drift

of ice from the Arctic Ocean, if indeed the surface current in Nansen Sound is southward. On the other hand the ice plug should favour the build-up of a surface layer of freshwater from runoff, and this could lead to a thickening of the ice to the south. In this connection it is worth noting that studies, supported by the Defence Research Board, of a relict plankton fauna in the glacially-dammed Lake Tuborg lead to the likely conclusion that the waters of the Arctic Archipelago were of generally lower salinity 3,000 years ago than at present (Bowman and Long, 1968), a condition that could have been caused by blockage of channels leading from the Arctic Ocean by ice shelves.

If the ice plug in Nansen Sound does reach the status of an ice shelf, defined by one authority as landfast ice with a freeboard of more than 2 m, it might acquire some legal significance from an extension of practice in Antarctica where ice shelves are "assimilated to land".

References

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