MASS BALANCE STUDIES ON THE ELLESMERE ICE SHELF

In the next paper Dr. H. Lister reported the results of recent work which included two profiles across the Ellesmere Ice Shelf, one of which ran across Ward Hunt Island. In both profiles an attempt was made to run a level traverse across the shelf. It was hoped that, by doing this before and after the ablation season, it would be possible to find the ablation including bottom melting. However difficulties were experienced both in locating sea-level using bore holes, and in allowing for tidal action, and it was not possible to close the level traverses very satisfactorily; the closure was about 15 in. (38 cm.). The expedition also studied the salinity of sea-water near the shelf and drilled cores to help identify the origin of the ice. Between Ward Hunt Island and Ellesmere Island itself there was white ice overlying very dirty ice, presumably an ablation layer, and this boundary intersected the surface ridge and trough system uncomformably. Thin-section studies on the cores showed that on the ice rise the material started as snow, while in the area of the embayment in the north-east corner of the ice shelf (from which it is thought the "ice island" T-3 broke away) the ice originated as frozen sea-water, a structure that is similar to that of the troughs of the shelf.

Dr. Lister then discussed possible theories of the origin of the ridge and trough system, including glacier pressure, barchan-like dunes, a mechanism in which water, blown from the troughs, would orient them parallel to the wind-rose maxima, and tidal warping. As evidence to help decide between these, the amount of snow lying in the troughs was about 30 cm. compared with about 20 cm. on the crests, so there is more snow in the troughs, however this acts as a blanket and keeps the ice in the troughs warm. The troughs seem somewhat different near the ice front, which may suggest that they form there, and Dr. Lister thought that it was likely that their formation was contemporary with the formation of the shelf, possibly being similar to the formation of pressure ice.

DISCUSSION OF DR. H. LISTER'S PAPER

Dr. G. de Q. Robin: I am interested in the ridge and valley systems in the Antarctic inland ice and ice shelves; I believe they are products of the motion of the ice shelves in some way or other. I have only seen one possible measurement of motion in this area of the Ellesmere Ice Shelf, and for that the possible errors were such that it could have implied that the ice shelf was stationary. Do you know of any other measurements in this region showing whether a point five miles out on the ice shelf is fixed in space or moving in any direction?

Dr. Lister: I do not know of any precise measurements, but comparison of air photographs suggest that the shelf position now is very similar to what it was when it was first photographed. In five years there has been no marked change.

Dr. Robin: Are there, or do you think there were in the past, any inland glaciers pushing into the shelf?

Dr. Lister: I do not think so. There have been some radio-carbon tests and these suggest that the shelf is not more than 5,000–7,000 yr. old.

Dr. Robin: If it is as old as several thousand years it would be difficult to imagine that these features on the surface have been preserved since the formation of the shelf.

Dr. Lister: Yes. There is a further complication I have not mentioned. During the ablation season the troughs fill with water, which runs out slowly but not fast enough to prevent candle ice forming at its surface, which, as further water drains out, gets left with an air gap beneath it. It is beautifully clean ice compared with the ice on the crests, so the crests, having the lower albedo, melt more, and can melt down below the level of the old troughs. Thus there can be a migration of the ridge and trough system. But, if you set off with a certain wave-length, will the secondary, or even the tertiary picture not be a reflection of what we had in the beginning?

MR. G. R. ELLISTON: Do you know how much tidal action affects the shelf? Does it move up and down significantly, or is there a hinge line on Ward Hunt Island, or perhaps against the mainland?

DR. LISTER: Yes, there is a hinge line on Ward Hunt Island, and because it became obvious that my profiles would take three days to make, we decided we must measure tide at Ward Hunt Island, at Ellesmere Island, and at the northern front of the shelf, with a man at each station, but a polar bear upset the man at the northern one, and this meant that we did not get a complete record there, and the others are still being worked out, but there is a total tide of about 2 ft. (60 cm.), so my 15 in. (38 cm.) could be largely due to that tidal change.

DR. W. H. WARD: I think I suggested to Dr. G. Hattersley-Smith that the wind might have something to do with this pattern. Is there any indication on the ice forming where that piece was detached on the north-east side? What is happening on the surface of the ice there in the winter?

DR. LISTER: It has a gentle ridge-trough system, but it is terribly gentle and it is most difficult to say when you have left this and gone onto the floe ice—there is just such a vague pattern on the sea ice.

DR. WARD: One gets this pattern in every narrow fjord every winter. It is formed by wind. You can certainly get a pattern of this type without tides.

DR. B. FRISTRUP: The problem is that this pattern formed by wind is on quite a different scale from what you see on the floating ice island. Looking down they are very easy to distinguish, even if you see them at the end of winter.