Journal of Glaciology, Vol. 24, No. 90, 1979

ABSTRACTS OF PAPERS ACCEPTED FOR THE SYMPOSIUM BUT NOT PRESENTED

THE MASS BUDGET OF THE LAMBERT GLACIER DRAINAGE BASIN, ANTARCTICA

By IAN ALLISON

(Antarctic Division, Department of Science and the Environment, 568 St Kilda Road, Melbourne, Victoria 3004, Australia)

ABSTRACT. Estimates have been made of the mass budget of the total drainage basin of Lambert Glacier. These show a small but significant positive state of balance for the interior basin (the accumulation area up-stream of the major ice streams) and strongly suggest a positive balance for the Lambert Glacier system (the region of major ice streams, between the Amery Ice Shelf and the interior basin). The total mass flux into the interior basin is estimated as 60 Gt a^{-1}. Results are presented from a number of ice movement stations established between 1972 and 1974 around the perimeter of the southern Prince Charles Mountains. These results, together with ice thicknesses from radio echo-sounding in the area, give a total mass outflux through the 2 000 m contour of 30 Gt a^{-1}, implying a budget excess of a further 30 Gt a^{-1} over the whole interior basin. Results from velocity and ice-thickness measurements give a mass discharge through a section near the junction of Lambert Glacier and the Amery Ice Shelf of 11 Gt a^{-1}. Losses within the Lambert Glacier system proper account for a further 7 Gt a^{-1} and an overall mass excess of 12 Gt a^{-1} is estimated for the Lambert Glacier system. This present positive state of balance contrasts with geomorphological evidence from the southern Prince Charles Mountains of a large drop in ice level in recent geological time, and the ice surface in the area may now be building up after a major recession.

This paper has been published in full in *Journal of Glaciology*, Vol. 22, No. 87, 1979, p. 223–35.

SURFACE CONTOURS AND FLOW PATTERN OF A PERFECTLY PLASTIC THREE-DIMENSIONAL ICE SHEET WITH ARBITRARY BOTTOM AND EDGE TOPOGRAPHY

By NIELS REEH

(Geophysical Isotope Laboratory, University of Copenhagen, Haraldsgade 6, DK-2200 Copenhagen N, Denmark)

ABSTRACT. The differential equation determining the elevations of a perfectly plastic three-dimensional steady-state ice sheet is set up. Analytical solutions of the equation are obtained in two simple cases, viz. (1) an ice sheet on a horizontal base with an arbitrary curve as edge and (2) an ice sheet on a plane but sloping bed, with an edge composed of straight-line segments. The solutions are discussed in particular with reference to the development of ice divides and ice streams.

For arbitrary bed and edge geometries, solutions are obtained by means of the method of characteristics, which reduces the problem to solving simultaneously three ordinary first-order differential equations. The integration, which is performed by numerical methods, is generally begun at the edge, where the necessary boundary conditions are known.

The method has been applied to model the elevation contours and the flow pattern of the Greenland ice sheet, using the bottom topography revealed by radio echo-soundings and the present edge geometry. The result is in surprisingly good agreement with our knowledge of the ice-sheet topography and flow pattern, all significant ice divides and ice streams being reproduced. This result suggests, that the method can be applied to model the shape and flow pattern of ice sheets under glacial conditions, using information about former ice-edge positions. This has been attempted for north-west Greenland and Queen Elizabeth Islands, with various ice-margin positions. The topography and flow pattern of the reconstructed ice-age ice sheets is discussed in the light of uplift data, and long $\delta^{18}O$-records obtained from Greenland and north Canadian ice cores.

THEORY OF DEFORMATIONS WITHIN ICE SHEETS DUE TO BOTTOM UNDULATIONS

By Sigfus J. Johnsen, Kjeld Rasmussen,* *and* Niels Reeh

(Geophysical Isotope Laboratory, University of Copenhagen, Haraldsgade 6, DK-2200 Copenhagen N, Denmark)

Abstract. Bedrock undulations of glaciers and ice sheets cause undulations of the ice surface and of internal layers. Models are constructed, that describe this phenomenon, using perturbation techniques and utilizing the stress function as harmonic solution to the full biharmonic equation. This approach is an extension of a previous treatment of the problem, which was based on the solution of the Laplace equation. This solution is shown to be inadequate. Two types of ice flow, with and without bottom sliding, are considered. Furthermore, in order to cope with the variation of viscosity with depth, semi-analytical multi-layer models have been constructed.

For the models considered, transfer functions, relating amplitudes of surface and bottom undulations, phase angles, and variation with depth of perturbational stress and velocity components, and in particular of the amplitude of internal isochronic layers, are presented. The predictions of the models presented show significant differences mutually as well as compared with those of previous theories. This opens up the possibility of using field data to check the models and possibly draw conclusions regarding flow conditions at the ice–rock interface and regarding viscosity variations with depth.

* Present address: Geographical Institute, University of Copenhagen, Haraldsgade 68, DK-2100 Copenhagen, Denmark.