

DERIVED CHARACTERISTICS OF THE ROSS ICE SHELF, ANTARCTICA

(Abstract only)

by

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ABSTRACT

Results of the Ross Ice Shelf Geophysical and Glaciological Survey (RIGGS) provide the most complete data set available for any large portion of the polar ice sheets. In this paper, we use RIGGS data to calculate some ice-shelf characteristics. These include steady-state particle trajectories through the ice shelf and the depth of isochronous surfaces, which are of particular importance in choosing a drilling site where ice from the grounded West Antarctic ice sheet is likely to be near the surface. Our estimates for depth to ice originating from the 500 m elevation contour show good agreement with depths to a glaciochemical transition in four ice cores that is believed to be associated with this elevation. This suggests that, for much of the ice shelf, there have been no dramatic and sustained departures from steady state during the past 1.5 to 2.5 ka. With the RIGGS data and an assumed bottom-melting rate distribution we calculate steady-state temperature profiles at each of the measurement stations. Then, adopting an ice-flow law deduced from laboratory experiments and ice-shelf measurements, we obtain an effective flow-law parameter for each of

these sites. Using these values, the measured strain-rate field is transformed to an equivalent stress field over the ice shelf. The stresses are determined by the ice-shelf freeboard and by the force field exerted on the ice shelf by its sides and by ice rises, and our analysis yields estimates of these restraining forces F for the Ross Ice Shelf. An apparent increase in F very close to the ice front suggests that the ice shelf possesses a narrow seaward fringe of anomalously stiff ice. We suspect that this represents the effects of increased bottom-melting rates (and therefore colder and stiffer ice) very close to the ice front.

In order to illustrate the role of the restraining forces in controlling ice-shelf behavior, we calculate the strain-rate field for an unrestricted Ross Ice Shelf, i.e. one that is detached from its sides and contains no ice rises. Currently the creep-thinning rate for most of the ice shelf is 0.5 to 1 m a⁻¹ for an unrestricted ice shelf, but it would increase to 1 to 10 m a⁻¹, with values up to 60 m a⁻¹ up-stream of the ice rises.

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THE IMPORTANCE OF PRESSURIZED SUBGLACIAL WATER IN SEPARATION AND SLIDING AT THE GLACIER BED

(Abstract only)

by

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The effect of pressurized sub-glacial water on the sliding process is quantified by calculating a "bed separation index". The water pressure distribution is calculated assuming the existence of a Röthlisberger channel at the bed. Kamb's formulation is used to describe the variation of normal stress over periodic bed undulations. The hypothesis is that as either basal shear stress or water pressure is increased the extent of ice-bedrock separation (on the down-glacier side of undulations) increases and enhanced sliding occurs.

Data from three glaciers of widely varying size are used to test this hypothesis. For Columbia Glacier and "Ice Stream B" the importance of including the effects of water pressure in any "sliding

law" are pronounced. More complete data from the third test case, Variegated Glacier, are used to compare a number of possible formulations of sliding law which encompass the above hypothesis. A modified Weertmantype law appears to be most preferable while some possibilities, including Budd's lubrication factor hypothesis, are tentatively rejected.

Consideration of the temporal variations of the "bed separation index" reemphasize that, especially in the short time scale, variations of water pressure can dominate the sliding process. An order of magnitude increase in water discharge causes a hundred-fold transient increase in the water pressure.

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