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RHEOLOGY OF GLACIER ICE

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Abstract : The constitutive relation for glacier ice remains an issue in glaciology. This is evidenced by the recent appearance of several articles in the literature that report on interpretations of existing data and which draw conclusions ranging from newtonian viscous to power law creep for polycrystalline ice. In this paper we describe the results of a new analysis based on the height of bottom crevasses found in floating ice shelves. The analysis relates the effective stress in the glacier to the height of the crevasse. The power of this approach is that the computed stress takes into account all factors influencing the deformation of the ice shelf including ice rises and shear along the boundaries of the ice shelf. By comparing calculated stresses to measured surface strain rates, we are able to estimate the exponent in the flow law and the flow law constant. We find that strain rate increases as the third power of the deviatoric stress with a constant of proportionality equal to 2.3×10^{-25} .

COMMENTS

L.LIBOUTRY

- 1) "Back stress" seems to me a confusing term
- 2) Weertman's formula should be tested before being used for measuring stresses. It gives the instantaneous depth when fracturing, for a perfectly elastic medium. It can be larger than the steady-state depth. The latter should depend on the strain rate (or the deviatoric stress) rather than on the stress.

Reply by R.B.ALLEY :

In regard to your first point, the term "back stress" is firmly established in the literature, so we use it. As to the second point, we agree that further testing of Weertman's crevasse theory is warranted and would prove interesting. However, Weertman (J. Weertman, 1980, J. Glaciol. 25 185) has considered many possible effects on crevasses and allowed for them in his theory, and Jezek (K.C. Jezek, J. Geophys. Res., 89, 1925) has considered the applicability of this theory to the specific situation discussed here. We thus believe that the Weertman theory provides a good description of bottom crevasses on the ice shelf.