Geophysical Research Abstracts
Vol. 16, EGU2014-1372, 2014
EGU General Assembly 2014

Influence of the pre-existing microstructure on the mechanical properties of marine ice during compression experiments

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Marine ice is an important component of ice shelves in Antarctica. It accretes in substantial amounts at weak points and below ice shelves. It is likely to exhibit peculiar rheological properties, which are crucial to understand its potential role in stabilizing ice shelf flow. Weakly textured marine ice can be considered as the hardest type of isotropic ice in the natural environment. However, due to its location and consolidation processes, marine ice can be highly anisotropic. It then shows grain elongation and development of folds with sub-vertical hinges.

We present a new data set of unconfined uniaxial compression experiments on folded marine ice samples that have been cut at various angles to the folds. High resolution texture and fabric analyses are described "before" and "after" the deformation experiment. It is shown that, in the given stress configuration, the geometry of the anisotropy controls the rheological behaviour of the marine ice. Below 0.4 MPa (an upper limit for secondary creep in our experiments) folded marine ice is harder to deform than weakly textured ice when compressed parallel or perpendicular to the folds hinges, while the reverse is true for ice compressed at 45° of the folds hinges, an equivalent of simple shear in the plane of the folds. The observed range of values for the n exponent in Glen's flow law is between 2.1 and 4.1.