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Crystallography of marine ice from Nansen Ice Shelf, Antarctica: on the development of compression folding

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With the aim of gaining a better understanding of dynamic processes occurring at the transition between ice sheets, ice shelves and oceans in polar regions, we report here the results of crystallographic studies conducted in marine ice from Nansen Ice Shelf (NIS), Terra Nova Bay, Antarctica. Thin sections from two 45-meter ice cores retrieved on site (at respectively 7.5 and 24.5 km from the grounding line) were analyzed with the aid of an Automatic Ice Fabric Analyzer available at the Niels Bohr Institute (Copenhagen, DK). Crystal boundaries and lattice orientations were investigated using the Texture Toolbox (Durand et al., 2006). The crystalline texture of bulk ice displayed on the thin sections is conspicuous by its lack of bubbles, supporting, with other properties (e.g. bulk salinity, stable isotopes), the non-meteoric origin of the sampled ice. Contrasting ice fabrics were observed along both cores. A first crystal facies, which makes up most of the ice body and is characteristic of a frazil ice origin, consists of millimetric equigranular crystals with rounded boundaries. This facies is interspersed with a second one showing distinct elongated, rectangular, centimetric crystals defining conspicuous ribbons and folds in the ice. C-axis orientation patterns associated with these recrystallization structures are well defined and are characteristic of horizontal compression along the flow. We show with this study that the stress field at NIS is in striking contrast with common stress models in ice shelves, where compression along the vertical and lateral extension are envisaged. We surmise that lateral drag as well as pinning points play an important role in the NIS stress configuration.