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Characterization of subgrain boundary types in polar ice (EPICA-DML ice core)

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Deformation processes on the crystal scale of polar ice control a main portion of the internal flow of ice sheets and thus distribution of ice masses and supply of ice towards the oceans. Deep ice cores drilled through the polar ice sheets provide samples to study crystal properties versus depth and time/age. Traditionally, microstructural investigations in ice cores only utilize (mean) grain size and c-axes orientation statistics to characterize changes with depth. Recently available high-resolution crystal orientation measurements (X-ray Laue and Electron Backscatter Diffraction), on microstructures and crystallographic preferred orientations (CPO), in combination with optical analysis (microstructure mapping) provide deepened insight into deformation mechanisms and the associated rheology. The nature of deformation and recrystallization microstructures in an Antarctic ice core (EPICA-DML) has been studied and possible formation mechanisms are suggested. As, so far, the dominant deformation mechanism is assumed to be dislocation creep, our study focusses on subgrain boundaries and their possible formation processes. As subgrain boundaries are frequent features along the whole length of the EPICA-DML ice core, knowledge of their nature and formation processes are essential for our understanding of the flow of polar ice sheets and the relevant mechanisms, e.g. the evolution of CPO. We present the combination of morphological data and crystallographic orientation data. We characterize different subgrain boundary types according to their geometrical appearances and their crystallographic configurations, which can be used to interpret possible dislocation activities in the highly anisotropic ice.