Geophysical Research Abstracts
Vol. 17, EGU2015-2507, 2015
EGU General Assembly 2015

Identifying deformation mechanisms in the NEEM ice core using EBSD measurements

Ernst-Jan Kuiper (1,2), Ilka Weikusat (2), Martyn R. Drury (1), Gill M. Pennock (1), and Matthijs D. A. de Winter (1)

(1) Utrecht University, Utrecht, The Netherlands (E.N.Kuiper@uu.nl, +31 030 253 1409), (2) Alfred Wegener Institute, Glaciology, Bremerhaven, Germany

Deformation of ice in continental sized ice sheets determines the flow behavior of ice towards the sea. Basal dislocation glide is assumed to be the dominant deformation mechanism in the creep deformation of natural ice, but non-basal glide is active as well. Knowledge of what types of deformation mechanisms are active in polar ice is critical in predicting the response of ice sheets in future warmer climates and its contribution to sea level rise, because the activity of deformation mechanisms depends critically on deformation conditions (such as temperature) as well as on the material properties (such as grain size).

One of the methods to study the deformation mechanisms in natural materials is Electron Backscattered Diffraction (EBSD). We obtained ca. 50 EBSD maps of five different depths from a Greenlandic ice core (NEEM). The step size varied between 8 and 25 micron depending on the size of the deformation features. The size of the maps varied from 2000 to 10000 grid point. Indexing rates were up to 95%, partially by saving and reanalyzing the EBSP patterns.

With this method we can characterize subgrain boundaries and determine the lattice rotation configurations of each individual subgrain. Combining these observations with arrangement/geometry of subgrain boundaries the dislocation types can be determined, which form these boundaries. Three main types of subgrain boundaries have been recognized in Antarctic (EDML) ice core[1,2].

Here, we present the first results obtained from EBSD measurements performed on the NEEM ice core samples from the last glacial period, focusing on the relevance of dislocation activity of the possible slip systems. Preliminary results show that all three subgrain types, recognized in the EDML core, occur in the NEEM samples. In addition to the classical boundaries made up of basal dislocations, subgrain boundaries made of non-basal dislocations are also common.

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