Sub-grain boundary features in ice cores from EDML, Antarctica

Introduction - Method

The ice-core record is of great importance for understanding past climate change. The investigation of ice cores provides the formation and evolution of new grain-boundaries via sub-grain boundary (sGB) density measurements for help during measurements of c-axes orientations. Therefore interference colors showing the same region of sample. Upper picture (2062 m depth). Upper and lower picture each from EDC core, Antarctica, France. (Note: C-axes orientations are encoded in colours (right). Pictures show same part of a section in each case. C-axes orientations are encoded in colours (right).)

Sub-grain boundary types

typical types occur together in the same core. A performance of grains showing only zigzagging sub-grain boundaries over whole grains with sGB boundaries only, in the shallowest part of the core might be due to the first samples and their relatively small sub-grain distributions. Such interpretation of this features is not yet available. In most depth ranges both types occur commonly.

Sub-grain boundary sites in the grain

eGB within the grains are not distributed homogenously but often appear localized accumulated adjacent to GB, especially at ridges. eGB can be seen (Fig. 4b) in the core. During the investigation of the samples, 20 to 60% of all grains per sample have been marked to show three types of eGB-features: 1. Zigzag-shaped eGB in small grain size. 2. Parallel to twin interface (within boundaries or on micro grain plane) within grain size. 3. Same trend perpendicular to other.

Sub-grain boundary frequencies and densities

Correlation of frequency of sGB containing grains (Fig. 3a) and sGB density (Fig. 3b) with depth are not found. Grain size (Fig. 3c) in the upper half of the core is nearly constant and shows a significant increase with depth only in the deepest part of the core and is nearly modulated by climatic (inconsequence) changes. Because of these two findings a particular depth of peak polygrainization, which should terminate grain growth and show a significant decrease in eGB occurrence, cannot be defined.

Samples with higher average grain size have more grains showing sGB (Fig. 3d), which might be due to probability of sample cutting effects (large grains at the bottom of the core). This effect is less seen in the upper average grain size of sub-grain containing grains compared to all grains (Fig. 3e). However less grains per area (higher eGB density) are found in samples with larger grains. Samples with small grains are from cold periods (Fig. 3a and 3b) and small grains. This ice core has lower grain density in the upper half of the core, which might be due to probability of sample cutting effects. newly formed sGB are more frequent compared to all grains (Fig. 3e).

Conclusions

An onset of polygrainization/graingrowth reorientation/recrystallization cannot be found. Indeed shows that the sub-grain formation is in some void in the main GRG, car. This indicates that the observed behaviour of recrystallization regimes (1. Grain growth, 2. Polygrainization-grain hierarchy recrystallization, 3. Migration recrystallization) is not well applicable here and has to be reconsidered.

Samples from the cold stages of the last glacial period (containing cloudy bands and high impurity concentration) have the highest sGB densities. Delineation productivity and activity in higher leading to more GB in impurity laden ice, such that micro particles act as source and together with GB as dissolution competent barriers.

Locally very restricted differences in deformation intensity can occur, namely inside single crystals, indicated by heterogeneous distribution of dissolution features. The result that the two types of GB are similarly alike, indicates that edge and screw dislocations play a similar important role in the beginning stage of polygrainization. Although it cannot yet be determined if both types develop equally into GB.

References

Hamann, I., Kipfstuhl, S., Faria, F. 2004. Personal communication. Antatctica, France. (Note: C-axes orientations are encoded in colours (right).)

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