UTRECHT UNIVERSITY

Quantification and analysis of subgrain boundaries in the NEEM ice core, Greenland

Niels Knotters

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1st supervisor: Martyn Drury

2nd supervisor: Ernst-Jan Kuiper

Conclusion

In this research an extensive analysis on both grainsize and subgrain boundary density was performed. Several interesting conclusions can be drawn from this research as discussed in the discussion

- Numerous subgrain boundary types can be found within the NEEM ice core. N-type typically formed by the dislocation glide on the basal plane. P-type subgrain boundaries can have multiple origins and further analysis on these boundaries might be necessary. Z-type subgrain boundaries are most likely formed due to dislocation glide on multiple glide planes to accommodate the stress.
- Grainsize is affected by the formation and evolution of a dislocation wall developing into a subgrain boundary and ultimately a new grain boundary. Data shows a decrease in grainsize in the upper hundreds of meter, despite other observation in other ice cores. A measurement flaw can be used as an explanation, since small grains formed, due to relaxation, probably were taken into account. This lowers overall the grainsizes. Another possibility is that other observations do not take into account all grains present in the ice core. Small grains can form due to rotation recrystallization that effectively reduce the grainsize.
- Subgrain boundaries tend to reflect the amount of strain in the ice core, with increasing density showing an increase in strain. At 1000-2000m depth the density becomes constant, likely caused by reaching a steady state for the subgrain boundary density. Other possibilities for the constant subgrain boundary densities can be found with stress and strain becoming more constant in the mid-level depths of the ice core. In deeper sections the density decreases due to SIBM with nucleation and strain softening occurs followed by an increase in strain rate, tertiary creep.
- Glen's flow law proposed for creep in ice is not a good description for the flow in ice. Microstructures and grainsizes are not taken into account in Glen's flow law, despite their importance in ice. Also Glen's flow law is based on secundairy creep in ice and is not representative for the whole ice sheet. A new flow law must be formed in order to address the problems with grainsize, microstructures and to address flow in the whole ice sheet.

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Databases, software and other online sources

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ImageJ:
Open source software found on https://imagej.nih.gov/ij/index.html

NEEM official website:
Additional information on the NEEM ice core can be found on http://neem.dk/

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