An analysis of the influence of deformation and recrystallisation on microstructures of the EastGRIP ice core

**EastGRIP Overview**

EastGRIP is the first deep ice core through one of our Earth’s ice sheets partly motivated by ice dynamics research. It is drilled downstream of the onset of the largest ice stream in Greenland, the North East Greenland Ice Stream (NEGIS). The two main findings regarding CPO (c-axes fabric) pattern are 1) a rapid evolution of c-axes anisotropy and 2) partly novel characteristics of the CPO patterns themselves. To gain a better understanding of the dominating deformation mechanisms of NEGIS, different approaches considering different length scales were chosen (1700m versus 0.55m and 0.09m scale), including several case studies.

**Results of fabric analysis**

High-resolution images (5 to 20μm/pix), derived with a Large Area Scan Microscope (LASM), enable detailed investigations of grain shape, grain boundaries and sub-grain boundaries and therefore the possibility to find distinct features from deformation and recrystallisation in the microstructure.

Several grain-parameters were investigated, e.g. perimeter ratio and grain size, indicating the frequent occurrence of unusual irregular grains compared to lower dynamic sites [1]. Grains usually show irregular, circular or rectangular shapes rather than elongated shapes. Characteristic are also amoeboid grain shapes and sutured grain boundaries, typical features of grain boundary migration. Furthermore, “sandwiched” grains and strong gradients in grain size over only a few centimetres can be observed in various depth ranges.

**Fabric examples**

- **Perimeter Ratio and Grain Size**
  - Colour code for fabric trend images: the centre corresponds to the vertical ice-core axis
  - Perimeter Ratio = measure for grain irregularity [1]

**References**


**Hypothesis for novel Type I crossed girdle**

The results from our combined microstructure and fabric investigations show a CPO evolution from a broad single maximum (118m) towards symmetric and asymmetric type I crossed girdles (195-296m). Below an intermediate transition depth, a classic girdle starts to develop and reaches full strength in a depth of 500m. Therefore, we propose the hypothesis of dynamically changing deformation modes in the upper 500m of NEGIS, accompanied by an early onset of synrotectonic dynamic recrystallisation, as already stated for quartz [2]. On a scale of 100m, deformation switches back and forth between coaxial deformation (basal slip dominant) and progressive simple shear. This is due to an increasing rotational component of strain path or an increasing strain in simple shear. These processes are accompanied by 1) the elimination of locked up grains by grain boundary migration and 2) partially reoriented grains by selective recrystallisation [3, 4], resulting in a CPO found for the first time in ice: the type I crossed girdle.