Identification of deformation mechanisms in ice core samples

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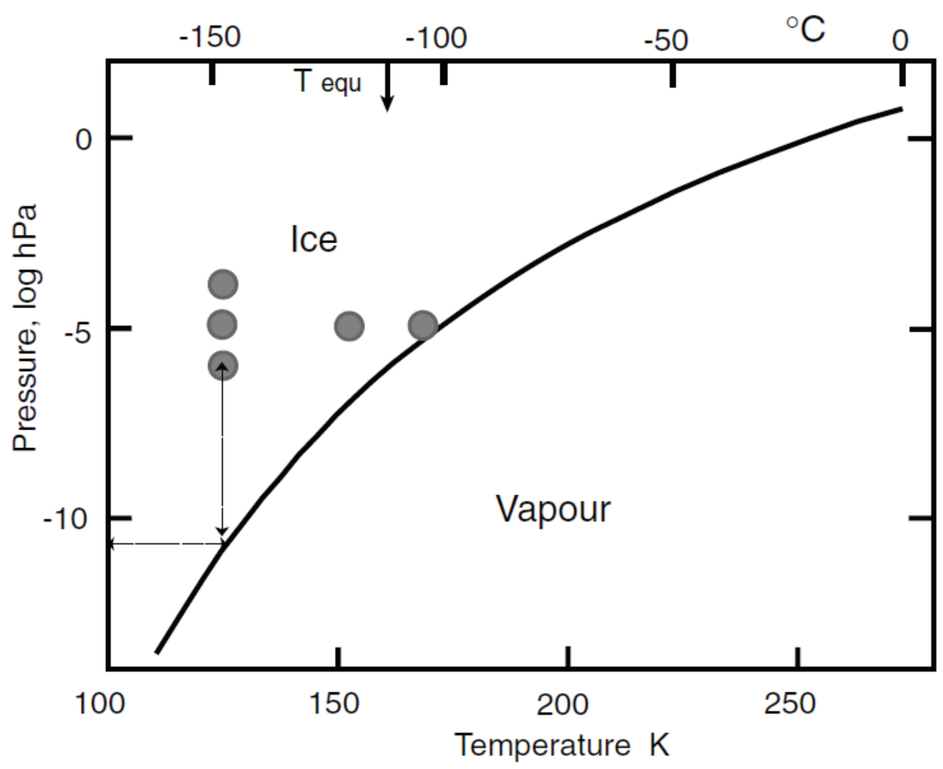
Objectives:

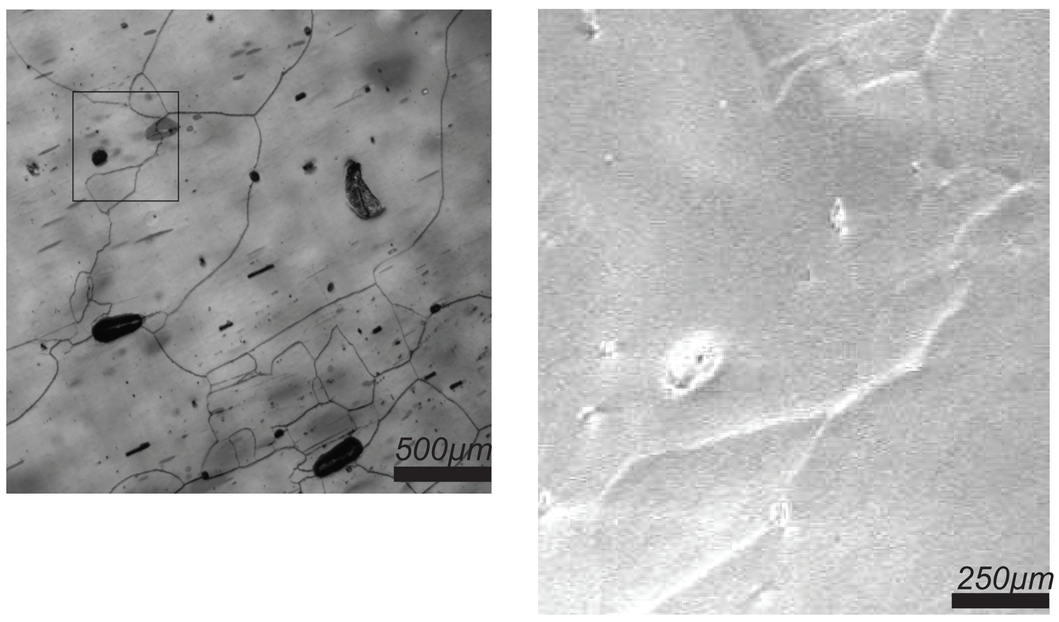
To determine active deformation mechanisms in polar ice. We use LM and Electron BackScattered Diffraction to identify possible slip systems of subgrain boundaries in EDML (Antarctica) and NEEM (Greenland) ice cores.

SEM conditions:

Pressure and temperature are chosen so that the sample is in the ice stability field. The electron beam is defocused slightly to minimize charging effects[1].



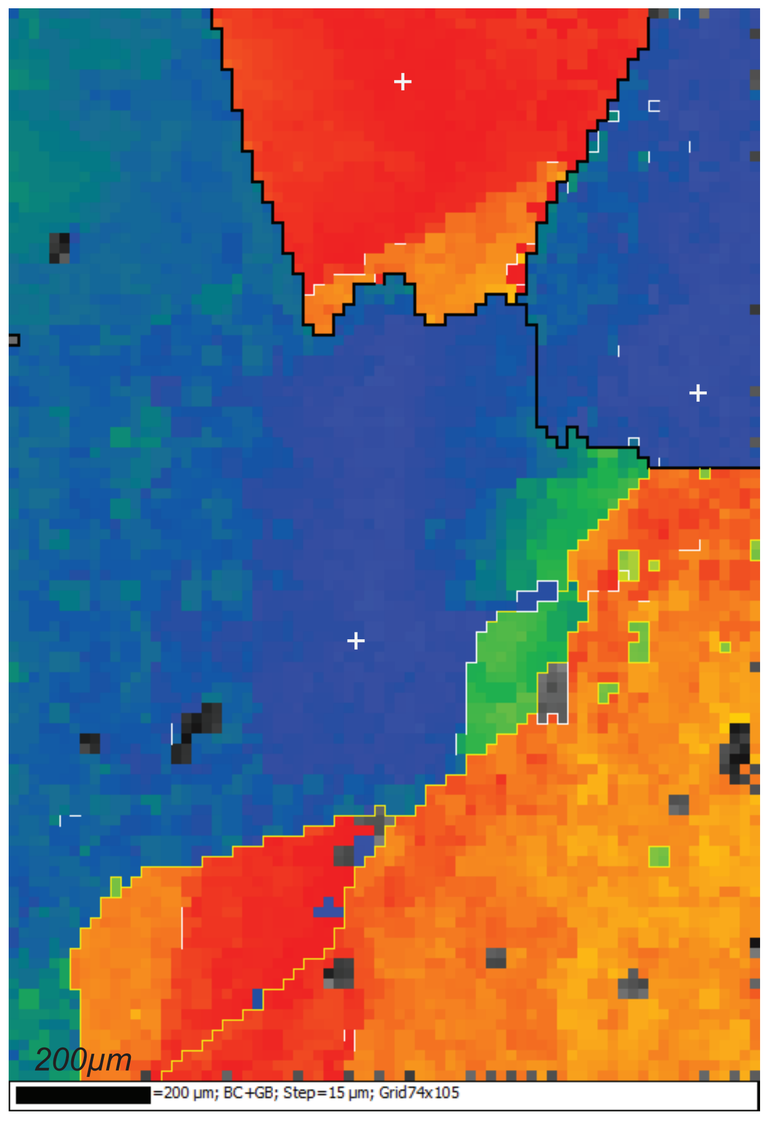
Light Microscopy:



Left, LM image taken shortly after polishing: square shows EBSD mapped area. Right, SEM image of the EBSD mapped area.

EBSD:

Mapped microstructure showing grain boundaries, subgrain boundaries and orientation gradient.



NEEM ice core, 1767 m depth. Boundary misorientations are: white 0.8°–2°, yellow 2°-10°, black >10°. Rainbow colour shows up to 5° difference in orientation from white crosses.

Substructures :

Analysis of subgrain LM boundary traces and EBSD orientation and misorientation data give information about the boundary types (tilt or twist) and possible active slip systems.

Conclusions:

The microstructure of low misorientation subgrain boundaries mapped using EBSD can be correlated with large area LM microstructures in natural polar ice samples. Analysis suggests that basal (tilt and twist boundaries) and non-basal dislocations (tilt boundaries) are active in polar ice[2,3].

References:

1. Weikusat et al. 2010, Cryogenic EBSD on ice: preserving a stable surface in a low pressure SEM, J. Microsc., doi: 10.1111/ j.1365-2818.2010.03471.x.
2. Andreas, 2007, New estimates for the sublimation rate for ice on the Moon. Icarus, 186, 24-30.
3. Weikusat et al. 2011, Subgrain boundaries in Antarctic ice quantified by X-ray Laue diffraction, J. Glaciol., 57, 85-94.