Contribution ID: **59** Type: **Talk**

What we can learn about dislocations in ice from EBSD analyses

Wednesday 10 January 2018 10:45 (20 minutes)

For some years now, Electron Backscattering Diffraction (EBSD) analysis has been applied to characterise, with high spatial and angular resolution the texture and microstructure of natural ice samples [Obbard et al. J. Glaciol. 2006], or artificially deformed samples [e.g. Piazolo et al. J. Microscopy 2008, Weikusat et al. J. Microscopy 2011]. Contrary to classical optical measurements performed on ice (Rigsby stage, Automatic Ice Texture Analyzer…), EBSD provides the full crystallographic orientation at every analysis point with a spatial resolution down to 0.5 micron.
When the resolution and the indexation ratio are large enough, full crystallographic orientations can be used to evaluate the lattice misorientations [Weikusat et al. 2011, Chauve et al. 2017 Phil. Trans. Roy. Soc. A], and therefore access information about Geometrically Necessary Dislocations (GNDs) that remain within the sample after deformation.
Piazolo et al. [2008] first used the "boundary trace analysis"to derive the type of dislocations consistent with EBSD data forming a given subgrain boundary. From that, GNDs in laboratory deformed samples appeared to be mostly basal, with an edge characteristic when forming the very common tilt or kink bands, or with a screw or mixed characteristics when forming more continuous substructures. More recently, Piazolo et al. [Acta Mater. 2015] and Chauve et al. [EPSL 2017] applied the Weighted Burgers Vector technique [Wheeler et al. J. Microscopy 2009] to well-indexed, high resolution EBSD maps, providing a more precise characterization of GNDs. The WBV technique derives a 2D equivalent of the Nye tensor from EBSD data collected from the sample surface. Although it does not provide the full misorientation tensor (the Nye tensor), this tool is well adapted to the limitation of the 2D orientation data extracted from EBSD measurements and enables to discriminate between the Burgers vectors of sampled GNDs.
Thanks to detailed WBV analyses performed on laboratory deformed ice samples (in compression and torsion), we were able, for the first time, to show that a non-negligible amount of GNDs have a Burgers vector component along the c-axis [Chauve et al. EPSL 2017]. This type of dislocations was rarely evidenced before, and has been assumed to play a minor role in the ductile deformation of ice [Hondoh 2000, Hokkaido Univ. Press]. Although GNDs do not directly relate to the dislocations responsible for local plastic gliding, the observed contribution of up to 30% of non-basal c-component GNDs points to a non-negligible role of such dislocations in ice viscoplastic flow, offering a more complex picture of the key plasticity processes responsible for ice deformation.
This presentation will detail the experimental observations and the WBV tool used to evidence the c-component dislocations in the laboratory deformed samples. We will then discuss the importance of such observations for defining constitutive mechanical laws for ice deformation modelling up to the ice sheet scale.

Significance statement

For the first time, the potential significance of non-basal c-dislocations is evidenced in polycrystalline ice, thanks to an original EBSD data analysis.

Author: Mrs MONTAGNAT, Maurine (IGE - CNRS - UGA)

Co-authors: Dr TOMMASI, Andrea (Géosciences Montpellier - Univ. Montpellier - CNRS); Dr JOURNAUX, Baptiste (NASA Astrobiology Institute - USRA - Univ. Washington - USA); Dr MAINPRICE, David (Géosciences Montpellier - Univ. Montpellier - CNRS); Dr BAROU, Fabrice (Géosciences Montpellier - Univ. Montpellier - CNRS); Prof. WHEELER, John (Univ. Liverpool, UK); Prof. PIAZOLO, Sandra (Univ. Leeds, UK); Dr CHAUVE, Thomas (UGA - CNRS - IGE)

Presenter: Mrs MONTAGNAT, Maurine (IGE - CNRS - UGA)

Track Classification: Mechanics & Microstructure