EGU2020-20424, updated on 09 Dec 2021
https://doi.org/10.5194/egusphere-egu2020-20424
EGU General Assembly 2020

3D Structure of NEGIS shear margins from radar stratigraphy

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The North East Greenland Ice Stream (NEGIS) is delineated by well-defined shear margins, which are evident in the gradient of surface velocity field as well as in the surface topography, where they form troughs up to ten meters deep. In the upper part of the ice stream the margins appear not to be linked to bedrock topography. To understand this efficient system of mass transport towards the ocean it is essential to investigate the nature of the shear margins, as here very localized deformation decouples the inner ice stream from the slower flowing surrounding ice sheet. This process is influenced by several factors and feedback mechanisms, including the crystal fabric orientation, strain heating and localization of meltwater. In summary, the shear margins are area-wise a small part of the ice stream itself, but the processes leading to the localization of deformation are of similar importance for ice discharge as the processes enabling fast flow of the main trunk over the bed.

We present results from an airborne radar survey with the AWI Ultra-Wide Band Radar system, covering an area 150 km upstream and 100 km downstream of the deep drilling site on the ice stream (EGRIP). Over the survey area the ice stream accelerates from 12 m/a to 75 m/a. We focus on the signatures of the shear margins in the radar data. In the regions of localized shear, the internal reflections in the radargrams show disturbances in the form of steep undulations, or chevron folds, which are intensified with ongoing shear. As the ice stream has been covered with 36 flow-perpendicular radar sections we are able to show the evolution of these characteristic signatures over the survey area, and thus, as an analog, over time. 3D-representations of the folded stratigraphic layers reveal how new folds are formed when the ice stream widens and how older structures are preserved in the outer part of the main trunk, where they are no longer subject to shear. Furthermore, we link the change of the shape of the internal reflections in the shear zones to a strain rate field calculated from high resolution flow velocities derived by TerraSAR-X data.