EGU24-4569, updated on 29 Apr 2024
https://doi.org/10.5194/egusphere-egu24-4569
EGU General Assembly 2024


# A structural geologist's view on the Northeast Greenland Ice Stream

**Paul D. Bons**[1], Steven Franke[1], Daniela Jansen[2], Yu Zhang[1], and Ilka Weikusat[1,2]
[1]University of Tübingen, Dept. of Geosciences, Tübingen, Germany (paul.bons@uni-tuebingen.de)
[2]Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research, Bremerhaven Germany

The Northeast Greenland Ice Stream (NEGIS) is a fascinating, over 500 km long structure in the Greenland Ice Sheet. The ice stream shows many features, such as folds and shear zones, that are also common in other ductile rocks. Geological methods and expertise may contribute to a better understanding of NEGIS and similar deformation structures in ice sheets. It is standard practice in oil and gas exploration to create 3D-structural models from parallel seismic lines. This approach, applied to radar profiles, is relatively new in glaciology (Bons et al., Nat. Comm. 2016, DOI: 10.1038/ncomms11427) but provides far more insight into the structural architecture and evolution of ice sheets than single radar sections. A 3D-structural model of upstream NEGIS reveals how pre-existing folds are offset within the ice stream. With that, classical strain analysis methods can be applied to quantify the deformation of these folds in the shear margins. This reveals that the total offset at the level of the EGRIP drilling project is in the order of up to 75 km and that the finite shear strain in the shear margins is around 18. With present-day shear-strain rates in the shear margins, such a finite offset and shear strain are achieved in ≤2000 yrs. This strain analysis also proves that ice does not flow through shear margins, but that the shear margins instead advect with the ice. This means that 'flow lines' (which should better be called 'streamlines') are not the same as 'path lines', as is now often assumed. The two are only the same in a time-invariant velocity field, which does not apply to NEGIS. Shear zones in other ductile rocks show that rocks never flow through shear zones, but shear zones can shift or 'jump' to new locations, as is actually observed in NEGIS. Geological principles to analyse and date the formation and activity of salt diapirs and syn-sedimentary faults can also be applied to folds observed in and around NEGIS. This reveals that fold amplification inside the shear margins ceased about 2000 yrs ago, which can be explained by the formation of the shear margins and concomitant reorientation of the CPO. A combination of several structural geological methods thus enables constraining the age of NEGIS as we now know it to about 2000 yrs, which is much less than previously assumed. The surprisingly late appearance of NEGIS, as well as the demise of ice streams in the Holocene (based on 3D-analyses of folded stratigraphy; Franke et al., Nature Geosci. 2022, Doi: 10.1038/s41561-022-01082-2) indicates that ice sheets are very dynamic, mostly due to the highly non-linear (n=4) and anisotropic rheology of ice.