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Deformation Features and Disturbances in the Stratigraphy of the EastGRIP Ice Core

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The EastGRIP (East GReenland Ice core Project) Ice Core is drilled in a highly dynamic area, the North East Greenland Ice Stream (NEGIS), with a surface velocity of 55 m/yr, representing high flow rates in this area. All previous deep ice cores in Greenland were mainly drilled to find undisturbed ice for climate reconstruction. In contrast, the main purpose of this ice core is to increase our understanding of ice flow and linking it to deformation features shown in the physical properties.
Some of these deformation features can be made visible using the line scanner device. It scans a polished ice core slab illuminated by an indirect light source (similar to dark field microscopy) and thus makes internal features (e.g. impurities, bubbles, hydrates and partly grain boundaries) visible, creating a 10x165 cm image of the core. Light traveling though the core is reflected and scattered at these features thus causing the camera to detect a bright section where the impurity content is high (“cloudy bands”), whereas ice with a low impurity concentration will not reflect light and contribute a dark layer in the image (“clear bands”). This is used to make layering, i.e. the stratigraphy, visible. Ice from the last glacial period has a well layered stratigraphy resulting from fairly regular annual dust storms in spring to summer. As deformation increases and deformation modes change towards the bottom of the core, these layers will show disturbances and folding.
A strong relationship between the δ18O of the water isotopes in the ice core and the impurity concentration, derived from the visual intensity of different layers, can be observed. The correlation of these two makes way for a very precise correlation of the visual stratigraphy and their δ18O age, to analyze differences in deformation modes of ice from different climatic periods.
Main deformation in the upper part of the ice sheet is pure shear (stretching along the horizontal and thinning in the vertical) and simple shear in the bottom parts. The gradual change from pure to simple shear is seen in the development of small scale disturbances in the layers, such as wavy patterns. The evolution of these features into z- and s-folds is expected in greater depth. Hereby the layer will deform into a z- or s-shape, overturning a section of the layer. Wavy features, such as the ones seen here, have not been observed in other cores and could be associated to the highly dynamic drill site in NEGIS.