

EGU2020-8691

<https://doi.org/10.5194/egusphere-egu2020-8691>

EGU General Assembly 2020

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Glaciotectonics and tunnel valleys in the southeastern North Sea imaged by high-resolution multi-channel seismics

Arne Lohrberg¹, Sebastian Krastel¹, Daniel Unverricht², and Klaus Schwarzer²

¹Christian-Albrechts-Universität zu Kiel, Institute of Geosciences, Marine Geophysics & Hydroacoustics, Kiel, Germany

²Christian-Albrechts-Universität zu Kiel, Institute of Geosciences, Coastal Geology & Sedimentology, Kiel, Germany

Glaciotectonic disturbance of sediments and tunnel valleys are often found near the margin of former ice sheets. Hence, these landforms can be used to reconstruct the dynamics of former ice sheet margins. The direction of thrusts usually points perpendicular to the ice front. Considering heterogeneity due to local ice advances, this relation can be used to infer the regional forward direction of large ice lobes. Here, we present a dense grid of high-resolution 2D multi-channel reflection seismic data from the German sector of the southeastern North Sea imaging a buried glaciotectonic complex and tunnel valleys in unprecedented detail.

We have identified individual thrust sheets in an area of approx. 650 km² (combined with recent results of Winsemann et al. (2020)). All thrust sheets are buried and partly eroded at their top. Two major phases of thrusting with two corresponding detachment surfaces have been identified in the subsurface, of which the younger phase led to the deformation of sediments several kilometers further into the foreland. The thickness of individual thrust sheets differs between 180 and 240 m. Some thrust sheets have been cut by the subsequent formation of tunnel valleys with an overall incision direction ranging from east-west to northeast-southwest. The glaciotectonic complex is limited to its southeast by an updipping reflector, which represents the margin of a source depression.

The restoration of cross-sections shows that the thrust sheets transported sediments over more than a kilometer towards the northwest to west, which relates the formation of the thrust sheets and the source depression. The landforms are very similar to a hill-hole pair that led to the foreland thrust sheets, probably as a result of combined bulldozing and gravity spreading in the foreland of the ice margin. Their occurrence and the adjacent tunnel valleys leads us to assume that we identified the marginal position of an Elsterian ice lobe in the southeastern North Sea.

Reference:

Winsemann, J., Koopmann, H., Tanner, D.C., Lutz, R., Lang, J., Brandes, C., Gaedicke, C., 2020. Seismic interpretation and structural restoration of the Heligoland glaciotectonic thrust-fault complex: Implications for multiple deformation during (pre-)Elsterian to Warthian ice advances into the southern North Sea Basin. *Quat. Sci. Rev.* 227, 1–15. <https://doi.org/10.1016/j.quascirev.2019.106068>

