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Reactivation of the Osning Thrust in Central Europe: ice-sheet and lithosphere interactions during the LGM

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The Osning Thrust is one of the major fault systems in Central Europe and has a length of about 115 km. The polyphase tectonic evolution in the Mesozoic ranged from extensional movements in the Jurassic to reverse faulting and thrusting during an inversion phase in the Late Cretaceous (Baldschuhn & Kockel, 1999). New data indicate that the Osning Thrust has been active during the Weichselian glaciation. A series of complex metre-scale faults and related fold structures are developed within the Late Pleistocene fluvial-aeolian complex of the Upper Senne. The faults dip towards the north and show offsets in a range of several decimetres. Growth strata indicate a two-fold evolution of the structures. The faults evolved as normal faults and were later transformed into reverse faults, resulting in the formation of small-scale inversion structures with a typical harpoon or arrowhead shape. New OSL dates imply that the normal fault related syntectonic sediments were deposited during the LGM (Roskosch et al., in prep). Therefore, glaciotectonics can be ruled out as driving mechanism. Firstly, the ice margin at that time was approximately 220 km to the NE. Secondly, the formation of inversion structures in a glaciotectonic complex is difficult and unlikely. Feeser (1988) showed that in front of an advancing glacier, the maximum compressional stress is almost horizontal leading to the formation of low-angle thrusts. As the glacier approaches, the maximum compressional stress rotates and finally becomes vertical as the glacier overrides the area (Feeser, 1988). The latter would cause normal faulting. Therefore, a typical glaciotectonic scenario involves thrusting followed by normal faulting, not normal faulting followed by inversion, as documented here. A reasonable driving mechanism for the inversion structures is the reactivation of the Osning Thrust due to far field effect of ice loading and unloading during the Weichselian glaciation. During ice advance, the northward hanging-wall block of the Osning Thrust was forced down by the ice load, causing normal faulting. During unloading after ice retreat, reverse movements occurred at the Osning Thrust. In contrast to most of the other major faults in northern Germany, the Osning Thrust dips to the NNE and therefore was more likely to be affected by ice loading since the vector of the plane parallel shear stress points towards the load.

References:

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