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Late Cretaceous inversion tectonics in the Thuringian Basin (Germany) – The Finne Fault Zone as an example of a differentially inverted graben system

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The Thuringian basin (TB) is a sedimentary basin which can be described as a now largely isolated part of the North German Basin (NGB). The stratigraphic evolution of the TB was similar to the evolution of the NGB. The present-day structural configuration was created by several deformation events of extensional and compressional tectonics. The TB contains several NW-trending fault zones, of which the Finne fault zone is a prominent example. The Finne fault zone has raised the northeastern border of the TB with respect to its interior. Strongly varying stratigraphic offsets and juxtaposed lithologies suggest that the Finne fault zone locally acts as a barrier to regional groundwater flow toward the center of the TB. In other localities, deep saline water rises along permeable strands of the Finne fault zone. Detailed structural analysis is a prerequisite for understanding the hydraulic segmentation of the fault zone.

The Finne fault zone consists broadly of a system of graben structures, which were reactivated and overthrust during the late Cretaceous. Here, we present new results on the deformation history of the fault zone, based on detailed map analysis, fault displacement, by serial cross section balancing and 3D-geomodelling.

In our analysis, we divide the fault zone into four segments. The segmentation is due to overthrusting at an acute angle of a partially inverted graben system. This structural configuration can be explained by polyphase deformation with initial extension ($\sim$200-500 m) and subsequent contraction ($\sim$1-1.5 km). Our study confirms many earlier hypotheses. Earlier results are enhanced by modern methods and a unified 3D-model of the Finne fault zone is created. The structural evolution of the area is also influenced by the stratigraphy. The Mesozoic sediments comprise several clay, salt and evaporite horizons of low shear strength. These horizons developed distinctive décollement levels. For these horizons special deformation models were taken from the literature and were further developed.

Our study tries to give an overview of the deformation kinematics within the fault zone including the shear horizons, which were validated by 2D-balancing. It also hints at the influence of basement structures on fault zone development and evolution.