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Early Permian intrusions in the Paleozoic sediments of the Eastern North Sea area

Ole R Clausen (1), Katrine J. Andresen (2), and Jens A. Rasmussen ()

(1) Department of Geoscience, Aarhus University, Aarhus, Denmark (ole.r.clausen@geo.au.dk), (2) Department of Geoscience, Aarhus University, Aarhus, Denmark (katrine.andresen@geo.au.dk)

The study area is located in the Northern Permian Basin which in the eastern North Sea is separated from the Southern Permian Basin by the Ringkøbing-Fyn High. The Permian basins were initiated during thermal subsidence following a late Carboniferous- early Permian rifting phase associated with extensive igneous activity recorded across the entire North Sea Basin. The easternmost intrusions and extrusions have been associated to the "Skagerrak-Centered Large Igneous Province" that has an early Permian age of c. 297 Ma. Compared to the Southern Permian Basin which historically has been intensely investigated because of the known presence of hydrocarbons within the Paleozoic sediments, the Northern Permian Basin has gained much less interest outside the hydrocarbon producing Mesozoic graben systems. This is mainly due to an apparent lack of potential source rocks.

A major E-W striking northward dipping fault system characterizes the study area and causes rotation of older probably Paleozoic sediments and creates syn-tectonic sediment wedges. The syn-tectonic wedges most probably contain volcaniclastic sediments of the Karl Formation or sandstones of the Auk Formation, but it cannot be excluded that the earliest late Permian Kupfershiefer which is a potential source rock, has local depositional maxima associated to the basement faults. Salt structures which have been periodically active during the post Paleozoic dominate the northern part of the study area.

The Paleozoic intrusions observed in the hanging-wall segment of the E-W striking fault system are generally planar and strike parallel to the fault with a southward dip geometrically similar to antithetic faults. In contrast, the intrusions in the footwall segment show a much more complex pattern striking at a high angle to the E-W basement fault and outlining a sill complex, which in certain areas resembles a poorly outlined composite cone. The intrusions are not observed in the syn-tectonic sedimentary wedges and this combined with the general age of the intrusions suggests that the syn-tectonic wedges are of latest early Permian or earliest late Permian age.

The study demonstrates Paleozoic intrusions with a systematic orientation and geometry that most likely was directly controlled by the basement faulting. Syn-tectonic hanging-wall deformation represented by antithetic fractures is suggested to be the most important controlling factor for the intrusions at the hanging-wall. At the footwall a more composite geometry of the intrusions is observed, resulting in a much more complex compartmentalization of the Paleozoic sediments due to intrusions compared to the hanging-wall segment. The intrusions and especially the compartmentalization must be taken into account during evaluation of the hydrocarbon potential of the Paleozoic.