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Late Permian topography at the southern margin of the Northern Permian Basin: Paleogeography inferred from 3D seismic analysis

Ole R Clausen (1), Katrine J. Andresen (2), and Jens A. Rasmussen (3)

(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), (3) Department of Geoscience, Aarhus University, Aarhus, Denmark (geo06jar@geo.au.dk)

The Top Pre Zechstein (TPZ) surface in the North Sea Basin is often mapped because it reveals the total basement tectonics in the area. In areas where Zechstein salt is present halokinetic processes, differential subsidence, and Mesozoic faulting however significantly alter the TPZ surface.
The study area is located at the southern margin of the Northern Permian Basin in the eastern North Sea at the northern flank of the Ringkøbing-Fyn High. This area occurs approximately at the pinch-out line of the late Permian Zechstein salt and constitutes an excellent theater illustrating a range of salt-related problems.
The TPZ surface is characterized by an overall NNW-ward dip defining the northern flank of the RFH and is transected by a set of NNW-SSE striking faults, and a E-W striking set of minor faults. Salt structures in the northern part of the study area introduce velocity pull-up (artefacts) at the TPZ surface and furthermore cause intense faulting of the Mesozoic and Cenozoic cover sediments. Pronounced isolated topographic highs similar to hills can be observed in the southern part of the study area where no to very little Zechstein evaporites are present. In the central part where Zechstein evaporites are present, small topographic highs similar to ridges can be observed at the footwall crest of minor faults.
The Zechstein evaporites generally onlap towards the south in the study area but in the transitional zone around the hills, onlap from all directions onto the hills is observed. This suggests that the hills reflect paleo-topography developed during sub-aerial exposure before and perhaps during the deposition of the Zechstein sediments. The internal reflections within the hills show that they are composed of southward dipping sediments and very evident erosional truncations can be observed. The hills are aligned parallel to the major E-W striking basement fault, but are not directly associated to faults offsetting the TPZ surface. However, the alignment, the dipping of the strata which are exposed in the hills, and the similar seismic signature of the strata exposed in the hills indicate that the hills are remnants of a footwall high which is progressively eroded from the north. The ridges are associated with minor faults offsetting the TPZ surface, but more importantly the internal reflections within the ridges resemble those of Zechstein carbonate reefs observed in the southern Permian Basin.
The lateral distribution of the Zechstein facies and the adjacent land topography show that the topography at the TPZ surface was generated before and during the Zechstein due to faulting and relative uplift of footwalls. The footwall crests of minor faults constituted when flooded, areas with lesser water depth and consequently display different sediment facies.
The study thus demonstrates a unique and detailed insight into the TPZ paleogeography which has significant implications for the understanding of the geological development in the eastern North Sea Basin, and may be of importance during the evaluation of the future hydrocarbon potential of the eastern North Sea Basin.