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Salt tectonics and associated fluid migration and entrapment in the western part of the Norwegian-Danish Basin

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The western part of the Norwegian-Danish Basin is part of the Northern Permian Basin and encompasses a variety of Zechstein salt structures (pillows, rollers, diapirs and salt walls). The area has been studied for decades with respect to HC prospectively associated to salt structures as well a focus area for studies on conceptual evolution of salt structures and faults associated with the salt structures. Previous local studies on fluid migration and Direct Hydrocarbon Indicators (DHI's) in the area show a close relation between halo kinetics and local fluid migration.
In the present study we have used3D seismic data (approximately 3500 km2) to identify and describe A: large diapirs which have been active until the youngest Cenozoic, B: medium sized diapirs being active until the early Cenozoic, C: salt relicts creating small non active pillows, and D: small satellite structures related to type A. The salt structures are evenly distributed across the studied area, and we conclude that the structures were initiated during the late Triassic due to depositional controlled differential loading combined with differential subsidence.
DHI's are identified at various stratigraphic and structural settings associated to the salt structures and each structure type has different types of DHI's associated. The DHIs observed at the type A and B diapirs are located above or at the stem of the diapirs and are here interpreted as classic structural hydrocarbon traps associated with rising salt deforming the strata. However, the DHI's associated to type C salt pillows have a relatively small lateral extent, stratigraphically restricted to the Mesozoic succession; they are located above the apex of the pillow and have in general a seismically disturbed zone located beneath the DHI. The seismically disturbed zone resembles gas chimneys, but may also be related to minor deformation of the Mesozoic strata overlying the type C pillows.
A biogenic origin of the gas in at least some of the shallower DHI's is most probable. However, close to and around the type 3 pillows is the Zechstein salt absent due to the evolution of type A and B structures (weald points) enabling the migration of fluids from pre Zechstein into the Mesozoic succession. We therefore suggest that a Paleozoic source rock may have generated the hydrocarbons migrating semi laterally and stratabound to the apex of the type C pillows, and if a deformed zone was present migrating vertically to the level where the DHI is observed today. The DHI's associated to the type A and B diapirs may be sourced from the same source rock.
The lateral distribution (clustering) of the different saltstructures constrained by the 3D seismic mapping enables us to suggest a general halokinetic evolution model in the Norwegian Danish Basin, and the study confirms the idea that a deep source rock (probably Cambro-Silurian shales) is available in the western Norwegian-Danish Basin and that a complex interaction of different saltstructures, lateral variable deposition and focused deformation controlled the migration through the impermeable Zechstein level into different stratigraphic levels.