Permo-Carboniferous Salt Messing Up the Cenozoic Stratigraphy of the Sørvestsnaget Basin, SW Barents Sea

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Salt can strongly deform and may form structural traps of hydrocarbon accumulations in the overburden. The tectonically complex Sørvestsnaget Basin, SW Barents Sea, is characterized by a thick Quaternary sediment package and ongoing movement of Permo-Carboniferous salt. Here we study the interaction between glacial sedimentation and salt movement, and discuss the implications for petroleum exploration. We use 5,500 km^2 of high-quality 3D seismic data to establish the stratigraphy from Mesozoic to present-day. 11 horizons have been picked with an inline spacing of 200 m, followed by gridding to 12 m, horizon attribute extraction, potential field data integration, and seismic geomorphological interpretation.

The Base Cenozoic structure map shows multiple N-S oriented fault blocks, a well-expressed Senja Ridge, and three salt structures. Faults above these salt structures shape the basin geology of the overlying Paleogene, Neogene and Quaternary strata. The Eocene stratigraphy is characterized by strong soft seismic anomalies with underlying horizontal hard reflections above the salt structures. Faults originating from the salt structures limit these anomalies to a lateral extent of c. 10 km^2. During the Quaternary, the anticlines above the salt evolve both at the paleo-shelf and the paleo-slope, and shape radial basins with faults expressed above the crest. The Quaternary sequence includes multiple horizons with high-amplitude hard polygonal depressions and softly infilling strata around these faults, as well as stratigraphy-bound soft seismic anomalies above the salt structures.

Faults above the three salt structures act both as fluid-migration pathways and form structural traps for Eocene hydrocarbon accumulations, shown by positive-amplitude flatspots. Stratigraphy-bound soft anomalies in the lower Quaternary are interpreted as gas-charged early Quaternary sand beds, also identified in the surrounding wells. The rapid glacial sedimentation resulted in salt movement in different geological environments, with salt growing both in the shelf and slope domains. The polygonal depressions expressed along the crest of the salt basins are interpreted as glaciotectonic landforms. The cause for these repeated polygonal depressions along Quaternary reflections might be a combination of increased heat and/or fluid flow along faults and increased glacial erosion. This study shows that salt growing into overlying sequences results in a rich variety of morphologies kilometres above the salt bed, and an active hydrocarbon system. Salt movement is further shown to affect the thermal regime of the Barents Sea Ice Sheet. The well-constrained timing combined with the preserved landforms of the Quaternary sediment package allow a detailed modeling of salt movement in future.