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Leakage of hydrocarbons in a glacially influenced marine environment: Hammerfest Basin (Southwestern Barents Sea)

Enmanuel Rodrigues (1), Rolando di Primio (1), Zahie Anka (1), Daniel Stoddart (2), and Brian Horsfield (1)
(1) GeoForschungsZentrum, Potsdam-Germany (rodrig@gfz-potsdam.de/+49 331 288-1782), (2) Lundin Norway AS, Lysaker-Norway

The Barents Sea is characterized by a complex geologic history, especially the Cenozoic evolution, because it was clearly influenced by tectonic, palaeoceanographic and paleoclimatic events (Vorren et al., 1991; Dimakis et al., 1998). These events were determinant as they have caused the redistribution and leakage of the hydrocarbons in the system (Ohm et al., 2008). Present-day accumulations are underfilled and are known to have leaked in the past; however the timing and extent of the leakage are largely unconstrained. This study aims to assess and quantify the amount of hydrocarbons generated by the main source rocks present in the Barents Sea, and also to determine the proportion leaked to the hydro- or atmosphere. The different effects of glaciation and deglaciation, formation of gas hydrates, and possible destabilization, which also leads to the sequestration and release of gaseous hydrocarbons, were analyzed and a quantification of the amount of hydrocarbons leaving the system is being made.
The model reproduces most of the known oil and gas accumulations in the area, mainly in the most important reservoir: the middle Jurassic Stø Formation. The main sources for oil and gas are the Jurassic Hekkingen Formation and the Triassic Snadd and Kobbe formations. The phase state and volumetrics of the accumulations are currently being corroborated. The model predicts a slight overpressure in the reservoir (Stø Formation) due to the glacial influence. The cyclic loading and unloading of the basin during glacial and interglacial periods generated pressure fluctuations which reached up to 5 MPa in magnitude.
Our preliminary results allow to investigate how ice loading and unloading affected reservoir fill, spill and leakage. Also the temporal variability of gas hydrate stability conditions can be infered (for this model in the timespan between 1.00Ma and ≈11,500 years). A plot of temperature against water depth during the glacial and interglacial periods shows that during the glacial periods the shallowest parts of the basin are well within the gas hydrate stability zone, while during interglacial periods conditions are generally outside the boundary. Moreover, leakage from the reservoir is predicted to occur during the glacial periods and the leaked gas will probably end up trapped below the ice sheet. Modelled cumulative leaked volumes of methane from the reservoir are in the range of 200 x 10^9 kg. These results support the possible sequestration of methane in gas hydrates during the glacial periods in the Hammerfest basin and their likely desestabilization during the interglacials. The results of the project could be a contribution for the study of the paleoclimatic changes, since we are trying to quatify the amount of methane leaked to the surface, which is known to be a potent greenhouse gases.

References

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