



Source rocks, expulsion and uplift – an experiment with relevance to the Barents Sea

*Jon H. Pedersen, Rolando di Primio, Lorenz Schwark and Martin Stockhausen
Lundin Norway AS, University of Kiel*

Summary

A number of hydrocarbon source rocks are known from the south-western Barents Sea, ranging in age from Lower Carboniferous to Early Cretaceous. Commercial accumulations of oil and gas discovered to date (e.g. the Snøhvit field, the Goliat oil field and the Johan Castberg oil and gas discoveries) have been charged by organic rich marine mudstones within the Lower-Middle Triassic Klappmyss and Kobbe fms. and/or the Upper Jurassic Hekkingen Fm. These source rocks probably reached maximum burial in the Cenozoic and were subsequently uplifted and cooled. Well data (vitrinite reflectance/Tmax data vs depth trends) suggest net erosion of around 500-2500 m.

What effect does uplift (i.e. decreasing temperature and pressure) have on mature, expelling source rocks? An instrument located at the University of Kiel, the Expulsinator, was built to investigate source rock behavior during variable temperature and pressure conditions. Hence, it is possible to simulate both burial (maturation) and uplift (cooling) of a source rock. Oil and gas expelled during the simulation can be collected and quantified at various time steps throughout the experiment.

An immature core sample of the organic rich Upper Jurassic Draupne Fm. from the North Sea (TOC 5-7%, HI 400-500 mgHC/gTOC, Tmax ~425 °C) was used in a 420 hours experiment designed to simulate burial of a source rock to peak oil maturity level followed by uplift of 1.5 km, reproducing the burial and uplift history of the Barents Sea. Oil and gas was generated and expelled from the source rock during increasing heat and pressure (the burial phase). Interestingly, oil and gas was also expelled in the uplift phase of the experiment. Around 40% of the gas and 10% of the oil expelled in the experiment was released during the cooling and pressure reduction stages of the experiment.

Outcomes of the experiment were applied in a basin model of the northern Hammerfest Basin. Modelling using results from the Expulsinator experiment demonstrates that a significant amount of hydrocarbons may have been expelled from Upper Jurassic source rocks during Cenozoic uplift. Thus, it is possible that a potentially substantial proportion of hydrocarbon charge to traps in the Barents Sea post-dated the time of maximum burial of source rock.