Regional uplift estimates from shale and sand velocity trends in the Western Barents Sea

M.Sc. Student Nora Johansen

Norwegian University of Science and Technology, Norway.
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Abstract

The Barents shelf has been uplifted and eroded several times during Cenozoic times. This has had consequences for reservoir properties, and such changes modify the observed seismic signatures. Although this has been studied for many years, new data and new HC discoveries the recent years has shown that the detailed distribution and effects are not fully understood.

Here exhumation was estimated from well log velocity data using shale and sandstone for selected wells in the western Barents Sea, focusing on the Loppa High region and the Hoop Fault Complex. Using shale compaction, in this case for the Cretaceous Kolmule Formation, for uplift calculations, is a much used and robust method. But the estimates might be further enhanced by using sandstone uplift estimates for calibration.

The P-wave velocity trend in the Kolmule Formation was compared to velocity versus depth trend lines from the Upper Cretaceous Shetland Formation in the northern North Sea. Sandstone velocity versus depth and resistivity versus depth trends were also established and compared to published North Sea trend data. These trends were utilized in quantifying uplift in areas were the Kolmule Formation were not present and to calibrate the exhumation/net erosion estimated from shale velocity trends.

The uplift estimated from well will be used to calibrate uplift maps generated from seismic velocities. These maps was constructed by combining seismic 3D velocity data and the interpreted Top Kolmule seismic horizon.

The estimations show extensive and varying net erosion in the study area. The uplift estimates increases towards the east and north-east, and ranges from 900 to 1150 meters in the Hammerfest Basin, from 780 to 1220 meters in the Bjørnøya Basin, from 1470 to 1980 meters in Fingerdjupet, from 1130 to 1860 meters on the Bjarmeland Platform and Hoop Fault Complex and around 1300 meters on the Southern Loppa High. The calculated uncertainties also show considerable variations, and are largest where the Kolmule formation is thin and were a good velocity versus depth trend was difficult to establish.

While estimates from shale velocity trend seem to give consistent results, trends from sandstone might in some cases give erroneous results. This is due to the more

extensive diagenetic processes in sandstones compared to shales. Diagenetic forward modelling based on burial history and rock physics will also be tested and can potentially give better uplift estimates for areas not containing shales. The estimates on the Loppa High are probably not representative for the high itself because the wells are located at the southwestern margin of the high. Here new estimates will be included at a later stage, using sandstone diagenetic modelling. Preliminary uplift estimates from resistivity trends are significantly higher than the ones from velocities. Here more work is needed to fully understand the observed differences.