



Effects of glacial erosion on reservoir fluid pressure and fault reactivation in the Barents Sea

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Rapid glacial erosion can alter the local state of stress in a crustal segment. Here we present the results of assessment of the total depth of glacial erosion in part of the southwest part of the Barents Sea, focusing on the Hammerfest Basin, the Finnmark Platform, and the Loppa High. We use seismic data, as well as data on temperature and maturation from petroleum wells in these areas, as a basis for a numerical estimate of the glacial erosion in the area. Our basin-modelling results suggest a glacial erosion of 900 m for the Hammerfest Basin, 1100 m for the Finnmark Platform, and 1300 m for the Loppa High. Using analytical and numerical models, we show that this amount of glacial erosion is likely to have resulted in dramatic change in the local stress field in the area. In particular, the stress modelling indicates that the erosion lead to dramatic decrease in the vertical stress on the petroleum reservoirs in the area and, in addition, to a great increase in the horizontal crustal stresses, particularly at and close to the new erosional surface. Using analytical tunnel-crack and elliptical plate-bending models, we show that the glacial erosion first lead to fluid overpressure and thus expansion of the petroleum reservoirs and, following the expansion, to fluid underpressure. Our numerical models suggest that the erosion-induced changes in reservoir fluid pressure and horizontal stresses resulted in stress concentrations at the lateral ends of the reservoirs. Any faults (normal, strike-slip, and reverse) close to, intersecting, the lateral ends of the reservoirs are thus likely to have been reactivated as a result of the glacial erosion. Fault reactivation, and associated temporary permeability increase, may have allowed fluids in the lower half (primarily oil and water) of the reservoirs to escape (leak out), while fluids in the upper half (primarily gas) were retained. This may partly explain why gas is common while oil is very rare in the reservoirs of this part of the Barent Sea.