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The likelihood of fault reactivation and leakage during CO2-injection and gas production in the Snøhvit field, the Barents Sea

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The injection of CO2 in the Snøhvit field started on 22 April 2008, and was the second project of its kind after the Sleipner project (1996) to be realised in Norway. The plan is to dispose 0.7 million tons of CO2 per year into the Tubåen formation, which is located at a depth of 2700 m, about 100 m beneath the main gas reservoirs of the Snøhvit Field. The gas-producing and the CO2-receiving reservoirs are connected by two large fault zones and separated by a vertical distance (elevation difference) of only about 100 m. The permeability of these fault zones largely determines whether the injected CO2 remains within the reservoir, or if it is likely to leak out along the fault zones into the gas reservoir above.

The fluid-pressure increase in the lower reservoir due to the long-term injection of CO2 changes the local stress within and around the fault zones, and may, if the stress concentration becomes large enough, result in fault-zone reactivation and potential leakage. In addition to the risk of fault-zone reactivation and leakage, there may be complex reservoir-reservoir interaction, resulting in difficult-to-predict local stress fields that may affect the mechanical behaviour of both reservoirs. This interaction and the associated local stress field are partly due to the generation of potential fluid overpressure in the CO2-receiving reservoir and, at the same time, the generation of potential fluid underpressure in the gas-producing reservoir as a result of its long-term production.

We present results of analytical and numerical modelling based on rock- and fracture mechanics principles, where the boundary faults are modelled as zones (elastic inclusions) with various internal hydromechanical properties. The reservoirs themselves are modelled as fluid-filled cavities subject to varying internal fluid pressure and external stresses. These models allow us to determine the following factors: (a) the effects of fluid-pressure changes in the reservoirs on the local stresses in and around the fault zones; (b) the local stresses around and in-between the reservoirs, in particular the reservoir-reservoir interaction; and (c) the likelihood of fault-zone reactivation and associated leakage of CO2. We believe that these results are of great importance for a further assessment of the CO2-storage potential, and associated risks, in the Snøhvit Field.