**Numerical Simulation of CO2 Storage and Seismic Monitoring in Saline Aquifers**

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We perform a time-lapse seismic monitoring of CO$\_2$ storage at the Sleipner gas field in the North Sea, where CO$\_2$ separated from natural gas is being injected in the Utsira formation, a highly permeable porous sandstone 800 m below the sea bottom.

The model considers a poroelastic description of the Utsira formation based on porosity

and clay content, and takes into account the variation of the properties with pore pressure and fluid saturation. Moreover, the model considers the geometrical features of the formations, including the presence of shale seals and fractures and fractal variations of the petrophysical properties. The numerical simulation of the CO$\_2$-brine flow is based on the Black-Oil formulation, which uses the Pressure-Volume-Temperature (PVT) behavior as a simplified thermodynamic model. The corresponding equations are solved using a finite difference IMPES formulation.

We compute synthetic seismograms on the basis of the resulting saturation and pore-pressure maps. Wave attenuation and velocity dispersion, caused by heterogeneities formed of gas patches, are described with White's mesoscopic model to obtain an equivalent viscoelastic medium at the macroscale. The wave equation is solved in the space-frequency domain with a finite-element iterative domain decomposition algorithm. The fluid simulator models the CO$\_2$ injection, obtaining accumulations

below the mudstone layers as injection proceeds. We are able to identify the time-lapse distribution of CO$\_2$ from the synthetic seismograms, which show the typical pushdown effect. The proposed methodology allows to monitor the CO$\_2$ plume and analyze storage integrity, providing an early warning in the case any leakage may occur.