# Multiscale models and experiments of chemo-mechanical effects of $CO_2$ sequestration in carbonate reservoirs

ANNE SCHAD BERGSAKER, SIGVE BØE SKATTUM, DANIEL KESZTHELYI, BJØRN JAMTVEIT, DAG KRISTIAN DYSTHE

[1] Physics og Geological Processes, Department of Physics, University of Oslo, POBox 1048 Blindern, 0316 Oslo, Norway
a.s.bergsaker@fys.uio.no,s.b.skattum@fys.uio.no,daniel.keszthelyi@fys.uio.no,bjorn.jamtveit@geo.uio.no,d.k.dysthe@fys.uio.no

We study processes that may facilitate or endanger large-scale permanent storage of $CO_2$ injected to enhance oil recovery in Norwegian oil producing chalk fields. Recent results have established a new, emerging understanding of the chemistry and mechanics of chalk: High porosity chalks are protected from reaction with reservoir fluids by a passivating organic material. The chalk may be activated by pore fluid changes or by fracture growth due to stress changes and become highly reactive. This may result in rapid compaction and complete collapse of the reservoir and escape of stored $CO_2$.

We have recently developed a predictive model of carbonate compaction by pore failure and pressure solution[1,2] and applied it to the compaction of the Ekofisk chalk reservoir[3]. We present here peridynamic simulations of the deformation of measured chalk volumes obtained by FIB SEM and syncrotron X-ray tomography. The deformation mechanism is compared to the underlying assumptions of the compaction model and to novel in situ syncrotron X-ray tomography deformation experiments on chalk with $CO_2$ and water. The chemical effect of $CO_2$ in water on the calcite solubility is also included in the pressure solution of the compaction model and predictions from this new model are compared to core scale experimental data. The multiscale experimental and modeling approach results in a predictive chemo-mechanical model of carbonates with no fitting parameters.

[1] Japsen P., *et al A compaction front in North Sea chalk*. J Geophys Res, **116,** B11208 (2012)

[2] Keszthelyi, D., Jamtveit, B., Dysthe, D.K., *Modeling of carbonate compaction by pore failure and pressure solution,* J. Geophys. Res, submitted (2016)

[3] Keszthelyi, D., Jamtveit, B., Dysthe, D.K., *Compaction of North-sea chalk by pore-failure and pressure solution in a producing reservoir*, Front. Phys. **4,** doi: 10.3389/fphy.2016.00004