Danish Offshore Technology Centre
Technology Conference 2024

Using rock physics to monitor CO_2 content and stiffness of chalk during CO_2 injection and water flooding experiments in triaxial rock-mechanical setup

Ida Lykke Fabricius, Technical University of Denmark;*

Hanne Dahl Holmslykke, GeologicalSurveyof Denmark and Greenland;

Tobias Orlander, Geo –SubsurfaceExpertise

Depleted chalk fields in the North Sea Basin are under consideration for CO_2 storage. The advantage being huge pore volume, distance to inhabited areas and already existing infrastructure. A disadvantage could be the solubility of carbonates in carbonic acid causing concern for frame softening and consequent potential for pore collapse or fracturing. In order to evaluate the feasibility, chalk samples were tested in a triaxial rock-mechanical setup fitted with ultrasonic wave transducers.

Supercritical CO_2 was injected into water-saturated chalk under fixed stress ratio (σ_R/σ_A), SR, of 0.35, followed by waterflooding at constant stress below pore collapse stress, with creep phases in between. The procedure was done three times. Each sample was then brought to pore collapse at constant axial strain rate. Strain was monitored by LVDT and strain gauges. Velocity of ultrasonic waves were measured throughout. A corresponding sample was tested in a separate setup for clarifying geochemical effects.

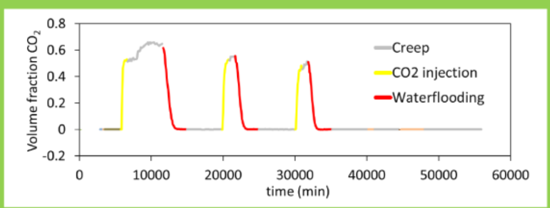
We find:

Up to 65% of the pore space becomes saturated with CO_2 upon CO_2 injection.

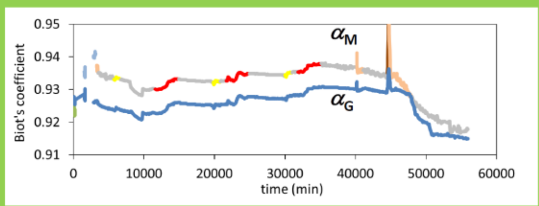
No indication of residual CO_2 after water flooding.

CO_2 injection followed by water flooding causes Biot's coefficient, α, to increase, indicating softening of the chalk frame. The softening is partially reversed during creep phases, and the net-increase in α is small.

The subsequent pore collapse and compaction of the chalk caused by increasing stress, causes Biot's coefficient to decrease to lower values than before CO_2 injection as an indication of work hardening.



CO_2 saturation



Biot's coefficient