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Integrating Acoustic Measurements and Microstructural Analysis to Assess The In-situ State of Stress of Sandstone Reservoirs

Suzanne Hangx (1), Hem Bahadur Motra (2), Bart Verberne (3,1), Annisa Trahwiwit (1), and Tessa Bosch (1)

(1) High Pressure and Temperature Laboratory, Utrecht University, Utrecht, Netherlands (s.j.t.hangx@uu.nl), (2) Marine and Land Geomechanics /Geotechnics, Institute of Applied Geo-science, Christian-Albrechts-University of Kiel, Kiel, Germany, (3) Geological Survey of Japan, National Institute of Industrial Science and Technology, Tsukuba, Ibaraki, Japan

Geomechanical reservoir modelling is one of the key tools used to predict reservoir deformation in response to exploitation of the subsurface, whether for hydrocarbon or geothermal energy production, or for the injection of CO_2 and waste water. However, to make such predictions, a better understanding of the reservoir state of stress is necessary. Pressure leak-off tests and wellbore break-outs are generally used to assess the in-situ state of stress of a reservoir. These methods require the creation of fractures near the wellbore, which may cause damage to the wellbore and potentially cause drilling problems.

We are investigation the potential to use core material to assess the in-situ stress state by performing true triaxial experiments on reservoir rock, coupled to measuring P- and S-wave velocities and microstructural analysis. We performed experiments on outcrop material from the Flechtingen sandstone (Beberthal quarry, Germany; ~6% porosity) and the Bleurswiller sandstone (Bleurville, France; ~25% porosity). True triaxial experiments were performed at the Christian-Albrechts University of Kiel, under dry and room temperature conditions. During the experiments, acoustic P- and S-wave travel times will be measured in the three principle stress directions (σ_1, σ_2 and σ_3). Microstructural analysis using optical microscopy will be coupled to the experimental results to quantify the microcrack densities of the samples prior to- and after deformation and to look at the orientations of the microcracks.

The experiments consisted of two stages each: 1) differential stress stage to induce damage in the sandstones, and 2) hydrostatic stress stage to assess if the stresses at which the damage was induced can be inferred from changes in wave-velocity and anisotropy. These experiments aim to provide a proof of concept for using true triaxial tests to assess in-situ stress states of reservoir rocks.