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NMR Measurements for Characterizing Tight Gas Reservoir Rocks

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This work was performed within the Tight Gas Initiative (TGI), a cooperation between Wintershall Holding GmbH and RWTH Aachen University. The objective is to improve NMR (nuclear magnetic resonance) interpretation for deducing gas and water content as well as absolute and relative permeability of tight gas rocks.
This project comprises three main phases: (1) Petrophysical characterization of the samples under investigation, (2) measuring desaturation curves (pressure dependent saturations) jointly with NMR relaxation data, (3) simulating multi-phase flow and NMR signal at pore scale (4) Comparison with two-phase flow experiments.
Longitudinal (T1) and transversal (T2) relaxation time NMR measurements are carried out under variable air-water saturations on 22 rock samples from a North Sea natural gas reservoir. The porosity of these samples varies between 1.6% and 9.7% and the permeability varies between 0.4 mD and 0.03 mD.
Negative pressures up to 4000 hPa were applied to drain the originally 100% water saturated samples. At each pressure level (saturation), T1- and T2- NMR relaxation measurements were performed. From the obtained desaturation curves, i.e. pressure dependent saturations, we estimated the relative permeability using the van Genuchten-Mualem model. In parallel, we work on pore scale simulations in order to link NMR with transport and storage properties of rocks. We use capillaries with triangular cross-section which are widely used to represent porous media. We studied the size and shape effects of triangular pores on the water distribution and NMR relaxation times at different water saturations (pressures). Our results show that the shape of the triangular pore strongly influences the pF curve and NMR signal. In the next steps, we aim to implement our simulations in a pore network mode to jointly predict flow and NMR properties of partially saturated rocks. The model will be constrained by comparing the predicted with experimental results.