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Petrophysical characterization of first ever drilled core samples from an active CO_2 storage site, the German Ketzin Pilot Site - Comparison with long term experiments

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Petrophysical properties like porosity and permeability are key parameters for a safe long-term storage of CO_2 but also for the injection operation itself. These parameters may change during and/or after the CO_2 injection due to geochemical reactions in the reservoir system that are triggered by the injected CO_2.

Here we present petrophysical data of first ever drilled cores from a newly drilled well at the active CO_2 storage site - the Ketzin pilot site in the Federal State of Brandenburg, Germany. By comparison with pre-injection baseline data from core samples recovered prior to injection, the new samples provide the unique opportunity to evaluate the impact of CO_2 on pore size related properties of reservoir and cap rocks at a real injection site under in-situ reservoir conditions. After injection of 61 000 tons CO_2, an additional well was drilled and new rock cores were recovered. In total 100 core samples from the reservoir and the overlaying caprock were investigated by NMR relaxation. Permeability of 20 core samples was estimated by nitrogen and porosity by helium pycnometry. The determined data are comparable between pre-injection and post-injection core samples. The lower part of the reservoir sandstone is unaffected by the injected CO_2. The upper part of the reservoir sandstone shows consistently slightly lower NMR porosity and permeability values in the post-injection samples when compared to the pre-injection data. This upper sandstone part is above the fluid level and CO_2 present as a free gas phase and a possible residual gas saturation of the cores distorted the NMR results. The potash-containing drilling fluid can also influence these results: NMR investigation of twin samples from inner and outer parts of the cores show a reduced fraction of larger pores for the outer core samples together with lower porosities and T2 times. The drill mud penetration depth can be controlled by the added fluorescent tracer. Due to the heterogeneous character of the Stuttgart Formation it is difficult to estimate definite CO_2 induced changes from petrophysical measurements. The observed changes are only minor.

Several batch experiments on Ketzin samples drilled prior injection confirm the results from investigation of the in-situ rock cores. Core samples of the pre-injection wells were exposed to CO_2 and brine in autoclaves over various time periods. Samples were characterized prior to and after the experiments by NMR and Mercury Injection Porosimetry (MIP). The results are consistent with the logging data and show only minor change. Unfortunately, also in these experiments observed mineralogical and petrophysical changes were within the natural heterogeneity of the Ketzin reservoir and precluded unequivocal conclusions.

However, given the only minor differences between post-injection well and pre-injection well, it is reasonable to assume that the potential dissolution-precipitation processes appear to have no severe consequences on reservoir and cap rock integrity or on the injection behaviour. This is also in line with the continuously recorded injection operation parameter. These do not point to any changes in reservoir injectivity.|