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# Pore size related properties during long-term $CO_2$-exposure experiments of reservoir sandstones and overlaying caprocks from the Ketzin pilot site (Germany)

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The long-term effects of injected $CO_2$ on the pore size related properties of brine-saturated rocks were investigated by simple batch experiments in high pressure autoclaves under conditions relevant for the Ketzin pilot site. $CO_2$ induced fluid-rock interactions may change porosity, pore geometry and size distribution, effective permeability, and capillary entry conditions. Knowledge of these pore size related data and their changes due to $CO_2$ injection is required for calibration of logging data and monitoring techniques, for reservoir simulations, and for estimation of static and dynamic storage capacities and reservoir injectivity.

Two sets of samples from the Ketzin pilot site (Germany) were investigated in this study: Set 1 represents reservoir sandstone samples from the Triassic Stuttgart Formation whereas set 2 represents fine-grained siltstones directly overlying the reservoir samples. For set 1, seven reservoir core samples from depths of 627 to 635m were exposed to pure $CO_2$ and synthetic reservoir brine at simulated reservoir conditions of 5.5 MPa and 40°C. After 15, 21, 24, and 40 months, the autoclaves were opened and rock and fluid samples were taken. For set 2, one cap-rock sample of the directly overlying siltstone from a depth of 625 m was split into 4 sister samples and exposed to $CO_2$ and synthetic reservoir brine at 7.5 MPa and 40°C. One of the sister samples was exposed to N2 (instead of $CO_2$) and served as blank sample. Run durations of the experiments were 2, 4 and 6 months for the $CO_2$ exposed samples and 6 months for the N2 blank run. Rock and fluid samples were investigated with respect to petrophysical characteristics and mineralogical and as well as fluid chemistry (see Fischer et al., this session).

Porosity and pore radii distribution have been determined before and after the experiments by NMR relaxation (CPMG) and mercury injection. While NMR relaxation data provide information on the fluid filled porosity (via NMR amplitudes) and the ratio of pore surface to pore volume and by this on pore sizes (via NMR-T2 values) mercury injection data provide information on area-equivalent diameters of the throats connecting the pore system. Based on empirical models, we estimate permeability and displacement, threshold, and critical pore pressure from mercury data. The porosities determined by NMR and mercury injection are comparable and agree well with logging data from the Ketzin pilot site. NMR and mercury injection data for set 1 samples generally indicate increasing porosity and a shift to larger pore sizes during the first months of the experiments. This increase in porosity is consistent with the measured increase in ion concentration in the fluid, suggesting dissolution processes. However, after 21 months run duration most samples indicate again decreasing permeability potentially indicating the on-set of secondary precipitation processes. Unfortunately, due to the heterogeneous character of the Stuttgart Formation it is generally difficult to distinguish between natural, between-sample variability and experimentally induced, $CO_2$ related changes. The NMR and mercury injection data for set 2 sister-samples of the siltstone sample show only minor changes with run duration. No changes have been observed in the N2 blank experiment.

Based on our data, the changes in porosity and pore size distribution of the siliciclastic reservoir and cap rocks of the Ketzin pilot site due to $CO_2$ exposure are only minor. The pore size related parameters are not significantly affected by exposure to pure $CO_2$ and thus the effects of injected $CO_2$ on reservoir capacity and injectivity are only marginal. The data indicate that the integrity of the reservoir and cap rock formation at the Ketzin pilot site is not affected.