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Analysing petrophysical parameters of reservoir rock from the Ketzin pilot site (Germany) during long-term CO_2-exposure experiments under thermodynamic conditions relevant for the geological storage of CO_2

K. Zemke (1), S. Fischer (1,2), A. Liebscher (1), and Ketzin Team ()

(1) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Centre for CO_2 Storage, (2) Berlin Institute of Technology, School VI, Department of Applied Geosciences, Chair of Mineralogy-Petrology

In the present study, 7 reservoir core samples from observation well Ktzi 202 at the Ketzin pilot storage site (Germany) were experimentally exposed to pure CO_2 and synthetic reservoir brine at simulated reservoir conditions of 5.5 MPa and 40°C. Reservoir rocks are immature arcosic to litharenitic sandstones of the Upper Triassic Stuttgart Formation. After 15, 21, 24, and 40 months, respectively, autoclaves were opened and rock samples were taken for petrophysical characterisation and mineralogical and microbial analyses. Brine samples were analysed with respect to organic and inorganic components.

Porosity and pore radii distribution have been investigated before and after the experiments by NMR relaxation and mercury injection. NMR measurements on brine-saturated rock core plugs potentially yield valuable information on the porous structure of the rock core. The distribution of NMR-T2 values (CPMG) reflects pore sizes within the rock core. NMR pore size is a derivative of the ratio pore surface to pore volume. The pore size derived by mercury injection is an area-equivalent diameter of throats connecting the pore system. Both methods produce petrophysical parameters required for calculating storage capacity and hydraulic properties (e.g. injectivity). Measured porosity data of the experimentally treated samples together with data from additional, untreated core samples from the Ketzin wells were also compared with results from wireline porosity determinations in the wells. Based on the NMR measurements, the permeability was calculated with standard parameters for sandstones after Timur-Coates. Mercury injection data was used to calculate sandstone permeabilities after Swanson (1981) and to furthermore determine the threshold pressure.

NMR and mercury injection data generally indicate increased porosities and a shift to larger pore sizes during the first months. This suggests mineral dissolution during the experiments in agreement with the observed chemical evolution of the brine over time. For some samples, the calculated permeabilities initially increase during the first 15 months. However, most samples exhibit decreased permeabilities after 21 months run duration. Due to the heterogeneous character of the Stuttgart Formation it is difficult to distinguish between natural, lithostratigraphic variability and experimentally induced, CO_2 related changes. Based on data after 40 months, the changes in porosity/pore size of the siliciclastic rocks of the Ketzin reservoir are only minor. These petrophysical parameters are not significantly affected by CO_2 with only marginal influence on reservoir capacity and injectivity of the reservoir rocks at the Ketzin pilot storage.