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A preliminary assessment of the contribution of CO_2 trapping mechanisms at the Ketzin pilot site

E. Klein, M. De Lucia, T. Kempka, E. Tillner, and M. Kühn

Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany (eklein@gfz-potsdam.de)

The FP7 European project CO_2CARE aims to support the large-scale demonstration of the CCS technology through the development of site abandonment procedures and technologies which guarantee the fulfilment of the requirements for geological CO_2 Storage. One of these requirements is the evolution of the storage site towards long-term stability. Four trapping mechanisms are acting towards long-term stabilization and immobilisation of CO_2: 1. Structural trapping, 2. Residual trapping, 3. Dissolution trapping, and 4. Mineral trapping. The quantitative contribution of each of these trapping mechanisms will be site- and time-specific.

By means of numerical modelling the four trapping mechanisms are evaluated in two separate steps for the Ketzin pilot site, where CO_2 is injected into a saline aquifer at a depth of about 630 m to 700 m. The contribution of structural, residual and dissolution trapping is determined by dynamic modelling using the Schlumberger Eclipse 100 black-oil simulator based on the latest version of the history matched static geological model of the Stuttgart Formation (CO_2MAN project). Mineral trapping capacity is evaluated through geochemical batch simulations using the PHREEQC simulator. Fluid and mineral composition are provided by a broad set of core analysis and experimental determinations (CO_2SINK and CO_2MAN projects) conducted for the Ketzin pilot site. Data on the dissolved CO_2 amount and water saturation supplied by the dynamic simulations are used to adjust the boundary conditions of the geochemical models.

With regard to the total contribution of the four CO_2 trapping mechanisms, being estimated for the time span of 3,000 years, the initial dominance of structural trapping decreases with the increase of dissolution trapping. It is expected that 50% of CO_2 are dissolved in the formation fluid within 500 years after injection, wherefrom a fraction slowly starts to incorporate into minerals due to chemical precipitation (mineral trapping). Residual trapping is determined by the migration behaviour of CO_2 and residual gas saturation among others.

As for mineral trapping in particular, of all carbonate minerals included in the model (siderite, calcite, magnesite and dolomite), siderite is the only one precipitating at the Ketzin pilot site. Variations of the reservoir pressure (and therefore of the amount of dissolved CO_2) in the expected range of 55 to 76 bar were found to have a negligible effect on mineral alteration. Decreasing the water saturation on the other hand, results in faster but quantitatively smaller reactions. The total change in mineral volume after 3,000 years can be considered irrelevant in terms of porosity changes.