Geologic CO_2 storage in arkosic sandstones with $CaCl_2$-rich formation water

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Abstract: The feasibility of geologic CO_2 storage in deeply buried arkosic sandstones has been tested using high-temperature, high-pressure, short-term physical experiments and long-term numerical simulations with CO_2-saturated solutions rich in $CaCl_2$. These conditions mimic the conditions found currently in the Eocene reservoir sandstones of depleted oilfields in the Dongying Sag, Bohai Bay Basin, China. Experiments at 100°C and 150°C and P_{CO2} of 4 MPa were conducted on sandstones rich in K-feldspar and plagioclase without anorthite. During the experiments, calcite and kaolinite precipitated, while plagioclase and K-feldspar partly dissolved. Ca^{2+} in the formation water was shown to be critical for mineral trapping of CO_2. The continuous dissolution of K-feldspar and plagioclase at a slow rate for a long time period can prolong the duration of calcite precipitation and increase geologic CO_2 storage capability by mineral trapping. Addition of NaCl, KCl, and $MgCl_2$ can prolonged the dissolution time of K-feldspar and plagioclase and precipitation duration of calcite. It also increased the quantity of sequestered CO_2 by mineral trapping. The process of geologic CO_2 storage can be divided into three stages. In stage I, calcite rapidly precipitates, and geologic CO_2 storage is dominated by solubility trapping within 100 years. Stage II lasts up to 300 years in the solution without NaCl, KCl, and $MgCl_2$ and 900 years with addition of NaCl, KCl, and $MgCl_2$ into the solution. In stage II, the precipitation rate of calcite abruptly decreases, but the quantity of mineral trapped CO_2 increases with increasing time. Geologic CO_2 storage is dominated by mineral trapping. In stage III, reactions reach equilibrium, and the quantity of geologic CO_2 storage reaches the maximum. The calculated quantity of CO_2 by mineral trapping in sandstones of the Es4x to Es3z members in the Dongying Sag is about 3.61 GT.