Core Flooding Experiments and Reactive Transport Modeling of Seasonal Heat Storage in the Hot Deep Gassum Sandstone Formation

Seasonal storage of excess heat in hot deep aquifers is considered to optimize the usage of commonly available energy sources. The chemical effects of heating the Gassum Sandstone Formation to up to 150 degrees C is investigated by combining laboratory core flooding experiments with petrographic analysis and geochemical modeling. Synthetic formation water is injected into two sets of Gassum Formation samples at 25, 50 (reservoir temperature), 100, and 150 degrees C with a velocity of 0.05 and 0.1 PV/h, respectively. Results show a significant increase in the aqueous concentration of silicium and iron with increasing temperature due to dissolution of silica and siderite. Increasing the reservoir temperature from 50 to 100 degrees C enhanced the naturally occurring weathering of Na-rich feldspar to kaolinite. Dissolution of quartz increased sharply above 100 degrees C and was the dominating process at 150 degrees C, resulting in a significant increase in the aqueous silicium concentration. At temperatures, 100 degrees C, the silicium concentration was controlled by a quasi-stationary state between feldspar dissolution and kaolinite precipitation whereas the concentration was kinetically controlled by quartz dissolution at 150 degrees C. Furthermore, a strong coupling between dissolution, precipitation, and flow velocity was observed. The results of this study show that the effects of heat storage of up to 150 degrees C in the Gassum Formation in the Stenlille area is expected to have only minor effects on the properties of the reservoir and that storage of excess heat in the Gassum Formation in the Stenlille area may be possible provided operational precautions are taken.

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