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Experimental study on rock-water interaction due to CO_2 injection under in-situ P-T condition of the Altmark gas reservoir, Germany

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CO_2 sequestration in depleted gas reservoir is an economically feasible option to mitigate global warming. The Altmark gas reservoir, located in the western part of the northeast German basin, was selected for enhanced gas recovery (EGR) by injecting CO_2. Under reservoir conditions (50 bars and 125°C), the injected CO_2 has very high solubility leading to subsequent dissolution and precipitation of minerals of the surrounding rock matrix. Therefore, the main objective of the current study is to investigate the geochemical changes in fluid composition due to dissolution of minerals under controlled laboratory conditions. Dry sandstone sample from the Altmark reservoir was mounted in an autoclave system and flushed by a pre-equilibrated mixture of water saturated with CO_2 at a constant flow rate at 50 bars and 125°C. The experiment was conducted for 100 hours during which fluid samples were collected at regular intervals and analyzed by Ion Chromatography (IC) and Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). pH was also measured in partially de-gassed samples.

Fluid analysis showed an increased concentration of Ca and SO4 at the beginning of the reaction time indicating the early dissolution of anhydrite. However, the Ca/SO4 molar ratio (>1) proved the dissolution of both calcite and anhydrite. The source of Na and K could be the dissolution of feldspars (albite and K-feldspar). Low concentrations of these two elements reflect the lower solubility and slow dissolution kinetics of feldspar minerals. Moreover, trace amounts of Mn, Mg, Zn, Cu and Fe might be derived from the dissolution of trace minerals in the sandstone. Besides, thermodynamic calculations of mineral saturation indices enabled an evaluation of the CO_2-water-rock interactions and highlighted the dissolution of the Ca-bearing minerals in the studied solution.