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Geochemical monitoring of a CO_2 injection into a caprock analogue

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The storage of CO_2 in geologic formations requires a caprock formation that prevents the buoyant migration of the CO_2. The 'Carbon Sequestration – Series D' experiment [1] aims to describe the behaviour of CO_2-saturated water in such a caprock and to gain understanding on the geochemical interaction between the injected CO_2, in-situ pore-water and the host rock. The experiment targets a fault zone in the low permeable Opalinus Clay, which mimics a typical caprock, in the Swiss rock laboratory of the 'Mont Terri Project'.

CO_2-saturated water was injected into the fault zone at constant pressure through an injection borehole from June 2019 to August 2020, The injected CO_2 has a low $\delta^{13}C$ value compared to the background. The injected water was also labelled with Kr and its inertness shall differentiate the physical transport and the impact of geochemical reactions.

A geochemical monitoring system was installed in a parallel monitoring borehole for the geochemical verification of the stimulated fluid transport. On-site monitoring included continuous, in-line measurement of pH, electrical conductivity and the dissolved gasses CO_2, O_2, N_2, He, Ar and Kr in regular intervals. These analyses were completed by off-line measurement of the waters' major ion composition and isotopic analysis of water and inorganic carbon ($\delta^{18}O$, $\delta^{13}C$).

Here, we present the monitoring setup and results of the experiment. We discuss the CO_2 migration through the fault zone and relate it to the purely physical behaviour of Kr. We also address He, which seems to characterize the mixing of injection and in-situ water.

[1] Zappone et al. (2021), Fault sealing and caprock integrity for CO_2 storage: an in situ injection experiment. doi:10.5194/se-12-319-2021