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Rock forming minerals reactivity in hydrogen environment – experimental and modeling study

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Depleted porous gas reservoirs could play a significant role in future underground hydrogen storage according to their abundance, already built infrastructure, and large storage capacities. It could be possible to store H_2 in TWh capacity in these sedimentary rocks. However, the investigation of rock-prorewater-H_2 interactions are still at initial phase. Unfavorable reactions with minerals that lead to H_2 loss have to be considered, as well.

The aim of our combined experimental and modeling study is to investigate the H_2-induced reactions, which can take place during underground H_2 storage (UHS). Based on a cores and cutting samples collected from a typical sandstone reservoir of the Pannonian Basin, an experimental series was performed. In these experiments, rock forming minerals were reacted with H_2 in distilled water to study the possible effect of H_2 on minerals under 100 bar of H_2 and at 105 °C to model UHS.

Fluid samples were collected during the experiments and analyzed by inductively coupled plasma optical emission spectroscopy to follow the dissolution of the minerals. Morphological observations with optical and scanning electron microscopy were carried out on minerals before and after treatments to follow the changes on the surface of the grains.

Furthermore, geochemical models were built in PHREEQC v.3 to estimate the rate of dissolution of primary minerals. The results shows that models resulting in carbonate dissolution should be reconsidered as they do not reproduce the experimental results. The K-feldspar remain stable while pyrite is reactive with H_2.