Kinetics of abiotic redox reactions of H_2 with hematite, goethite and smectite at geologic storage conditions (100 bar, ≤ 120°C)

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Abiotic redox reactions of hydrogen H_2 with minerals are in general kinetically hindered due to the high bond energy of the H-H bond. Therefore, abiotic reactions of H_2 proceed at low rates at temperatures < 100°C without catalytically active mineral surfaces [1]. As a consequence, the reduction of redox-active minerals like hematite and magnetite by H_2 has been mainly studied at elevated temperatures (250-700°C) due to its potential application for steel production [2]. However, for geotechnical applications like underground storage of H_2 (USH), the rates of abiotic redox reactions of H_2 with minerals or rock matrices at geologic storage conditions are essential for a quantitative description of the reactive transport of H_2 in the subsurface. Thus, long-term experiments at moderate temperatures of ≤ 120°C with suitable inert reactor material are necessary to derive the kinetic data.

To provide abiotic reacion rates of H_2, high-pressure batch experiments with H_2 and several redox-active minerals have been conducted in sealed gold tubes at ≤ 120°C and 100 bar. The redox minerals to be investigated, hematite, goethite and smectite, respectively, were selected according to their occurrence in the storage or cap rock of potential USH sites - salt caverns and sandstone reservoirs. First results of the experiments without water addition show a significant oxidation of H_2 by iron oxides within two weeks, e.g. by hematite. Consecutive experiments will provide additional kinetic data for the investigated redox reactions at reservoir conditions as valuable input data for future reactive transport modeling of H_2 in the subsurface.

[1] Truche *et al.* (2013) *Chem. Geol.* **351**, 217-228.
[2] Pineau *et al.* (2006) *Thermochim. Acta* **447**, 89-100.