Destructive effects of microbes on borehole materials during hydrogen storage

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Hydrogen storage in depleted gas reservoirs is an option when the energy supply from renewable ressources exceeds demand. Lab experiments are performed to investigate the effects of H_2 exposure on microbes in rock and fluid material and to assess how microbial processes affects the gas composition, the dissolution and formation of minerals as well as the integrity of steel components. Sandstone rock cores from the North German Basin (NGB) were incubated with hyper-saline fluid (salinity 235 g L^{-1}) in a H_2/CO_2-rich gas mixture at 35°C under atmospheric pressure and 41 bar overpressure. In addition, carbonaceous rock material from the Molasse Basin (MB) and a saline synthetic fluid (salinity 18 g L^{-1}) were incubated with the same experimental setup.

Under atmospheric pressure, a decrease in the H_2 and CO_2 concentration was observed in both setups. For the NGB, the H_2 and CO_2 decrease indicated the activity of hydrogenotrophic sulfat reducing bacteria (SRB) which were detected in the hypersaline fluid using molecular biological methods. This corresponded to the high sulfate concentration of 2110 mg L^{-1} in the fluid and detected H_2S and FeS scales. In saline fluids of the MB, with a 5-times lower sulfate concentration, SRB were not that dominant as H_2S was not detected. Therefore, the CO_2 decrease that went along with an increase in the volatile fatty acid concentration was likely caused by homoacetogenic bacteria, which were additionally favored by corroding steel components releasing H_2 into the solution. Under high pressure conditions, organic matter degradation by SRB increased the CO_2 and H_2S concentration in hyper-saline as well as saline fluids. In addition, the dissolution of the carbonaceous rock material was likely induced by acid-producing, homoacetogenic bacteria which in turn were favored by the CO_2 released from carbonate dissolution. Based on these first results and the following complete molecular biological and fluid chemical data, we will demonstrate which destructive effect microbes may have on borehole materials in a H_2/CO_2-rich atmosphere.