



The impact of hydrogen on potential underground energy reservoirs

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A reliable, safe, and long-term storage of energy in larger quantities is one, but still unsolved key issue in the realization of a sustainable, emission-free energy supply by renewable sources. Possibly the conversion of electrical power into hydrogen by electrolysis and its subsurface storage in geological structures is a feasible option. Hydrogen storage in salt caverns for chemical applications is already conducted for decades. However, appropriate salt deposits are limited at a worldwide scale. Therefore we investigate the suitability of such an underground H₂ storage in globally more common depleted gas reservoirs and natural gas storage sites of sandstone formations. Although these types of reservoirs have proven their tightness for millions of years, potential chemical reactions of injected hydrogen and the most heterogeneous rock compositions may affect their storage qualities. To evaluate such processes rock samples from six well locations in Europe and Argentina are used in laboratory batch experiments. In these tests the samples are exposed to hydrogen at site specific p-/T conditions and formation fluid compositions, ranging in temperature from 40 – 120°C, in pressure from 4 – 20 MPa and in fluid salinity from 16 – 350 g/l. Sandstone compositions are classified as arkoses to feldspathic litharenites with varying amounts of sulfate and carbonate phases. Before and after the experiments rock and fluid samples are classified by petrophysical, tomographic, mineralogical, and geo-/hydrochemical means, thus enabling the estimation of potentially induced mineral/chemical reactions during the tests. Such a comparison implies that two main types of reservoirs and related sandstone reactivity can be distinguished. Thereby in rocks of low saline, low temperature and low pressure environments any indications of mineral reactions caused by the presence of H₂ are lacking. This is in contrast to some samples of the high saline, high temperature and high pressure locations. There, in rocks without anhydrite, barite or calcite any evidence for mineral dissolution/precipitation is absent and rock porosity and permeability unchanged. However, in sulfate and calcite bearing sandstones these minerals are partially to totally dissolved, whereas silicate phases are unaffected by these experimental conditions. Because of the formerly pore filling occurrence of the dissolved sulfates and calcites the porosity is strongly increased after the tests and numerous new fluid pathways are generated. The enhancement in porosity and fluid pathways will increase the storage capacity of the sites but also will complicate any injection and recovery operations in practice due to the varying conditions in the reservoir. These first findings suggest that even within one single reservoir sandstone reactivity may vary in the presence of hydrogen. Thus detailed site characterizations are required before starting any H₂ storage operations.