Evaluation of geochemical reactivity of hydrogen in sandstone: application to geological storage

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The use of hydrogen as an alternative for electric energy storage has emerged recently. In the case of storage in sedimentary rocks such as sandstone, mineralogical transformations due to the presence of hydrogen may modify the porous structure of the rock and affect storage properties. In this study, the geochemical reactivity of hydrogen with sandstone was assessed both from experiments and geochemical modelling. The experiments were carried out at 100 and 200°C. Maximum hydrogen pressures of 100 bar were imposed and experimental durations ranged from 1.5 to 6 months. Limited mineralogical transformations were identified in experimental products, but the results undoubtly indicate that mineral reactions take place in sandstone during interaction with hydrogen. To complement the experimental data, geochemical modeling of interaction between sandstone and H2-bearing fluids was performed with PHREEQC. Under equilibrium mode, mica, clay minerals and hematite from sandstone react to new stable mineral phases which include Fe-bearing hydrous and anhydrous silicates and oxides. Therefore, both the experimental and theoretical approaches indicate that mineralogical changes should occur in the sandstone reservoir. However, the mineral reactions only concern muscovite, clay minerals and hematite. No changes have been found in the experiments for quartz and K-feldspar and the geochemical calculations show that both phases remain stable. Since quartz and K-feldspar are major mineral phases in sandstones, the sandstone microstructure is not expected to be significantly modified during interaction with hydrogen, even if minor phases such as muscovite or Fe oxide are progressively transformed. Therefore, the physical properties (porosity, permeability) that control the efficiency of sandstone as a reservoir will remain essentially unmodified. It is concluded that quartz- and K-feldspar-rich lithologies such as sandstone can remain highly stable upon interaction with hydrogen.