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Hydrogen underground storage in siliciclastic reservoirs - intention and topics of the H2STORE project

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The transfer of energy supply from nuclear and CO_2-emitting power generation to renewable energy production sources is strongly reliant to the potential of storing high capacities of energy in a safe and reliable way in time spans of several months. One conceivable option can be the storage of hydrogen and (related) synthetic natural gas (SNG) production in appropriate underground structures, like salt caverns and pore space reservoirs.
Successful storage of hydrogen in the form of town gas in salt caverns has been proven in several demonstration projects and can be considered as state of the art technology. However, salt structures have only limited importance for hydrogen storage due to only small cavern volumes and the limited occurrence of salt deposits suitable for flushing of cavern constructions. Thus, regarding potential high-volume storage sites, siliciclastic deposits like saline aquifers and depleted gas reservoirs are of increasing interest.
Motivated by a project call and sponsored by the German government the H2STORE ("Hydrogen to Store") collaborative project will investigate the feasibility and the requirements for pore space storage of hydrogen. Thereby depleted gas reservoirs are a major concern of this study. This type of geological structure is chosen because of their well investigated geological settings and proved sealing capacities, which already enable a present (and future) use as natural (and synthetic) reservoir gas storages. Nonetheless hydrogen and hydrocarbon in porous media exhibit major differences in physico-chemical behaviour, essentially due to the high diffusivity and reactivity of hydrogen. The biotic and abiotic reactions of hydrogen with rocks and fluids will be necessary observed in siliciclastic sediments which consist of numerous inorganic and organic compounds and comprise original formation fluids. These features strongly control petrophysical behaviour (e.g. porosity, permeability) and therefore fluid (hydrogen) migration. To reveal the relevance of these interactions and their impact on petrophysics and fluid mechanics in H2STORE six subprojects are included, which are devoted to various aspects of hydrogen storage in pore space reservoirs. The analytical and (laboratory) experimental studies will be based on rock and fluid samples issued from different reservoir sandstone and cap rock mudstone types originated from different depths all over Germany. Thereby data on sedimentological, geochemical, mineralogical, hydrochemical, petrophysical and microbiological rock composition will be gained. These studies will be completed with conceptual mathematical and numerical modelling of dynamic reservoir processes, including basin/facies burial evolution, mineralogical alteration, hydro-/geochemical reactions and gas mixing processes coupled with population dynamics of methanogenic microorganisms and dynamic displacement instability effects. The estimation of the hydrogen impact on reservoir behaviour of different rock types at depths will enable an evaluation of the feasibility of "Eco-/Green" methane and synthetic natural gas (SNG) generation by hydrogen reaction with CO_2. The verification/falsification of specific processes will also enhance predictions on the operational reliability, the ecological tolerance, and the economic efficiency of future energy storing plants. These aspects are main motivations for any industrial investors and the public acceptance of such new technologies within the framework of an overall power supply by renewable energy production.