

Hydrogen reactivity with an aquifer – PHREEQC geochemical thermodynamics calculations

Nicolas Jacquemet ^{*1}, Pierre Chiquet ², Arnaud Grauls ²

¹ Independent researcher/consultant in hydrogeochemistry and reactive transport - France

² Teréga - France

TEREGA has been using for 60 years an aquifer in southwestern France to store natural gas. This would be a potential host for hydrogen co-storage. In this context, we evaluated through PHREEQC geochemical thermodynamics calculations the possible rock-fluid interactions and their consequences on the reservoir porosity.

The following reactions were predicted: methanogenesis (conversion of carbonates to methane), accompanied by an alkalisation of the water; ferric iron; sulphate; disulphide; and nitrogen reductions by hydrogen. These reactions led to the reductive dissolutions of the reservoir rock minerals calcite, goethite, barite and pyrite. Dissolution of kaolinite was also predicted, due to the alkalisation of the water. The released elements/compounds precipitated as iron sulphide and zeolite minerals while baryum and sulphides accumulated in the water. The mineral dissolution-precipitation reactions did not affected significantly the reservoir porosity.

These results need to be put in perspective regarding the maximizing assumptions of constant hydrogen fugacity and thermodynamic equilibrium reaching. Our study could be improved by: (i) including kinetics for hydrogenotrophic microbial metabolic as well as for mineral dissolution-precipitation reactions; (ii) considering the advective-dispersive-diffusive transport of hydrogen within aquifer. Our modelling results will be compared to the outcomes of the laboratory tests of the R&D project RINGS (Research on the Impact of New Gases in Storages).

Mots-Clés : underground hydrogen storage, aquifer, gas-water-rock interactions, methanogenesis, iron reduction, sulphate reduction, hydrogeochemical modeling, PHREEQC