Title

Thermo-Hydro-Bio-Chemo-Mechanical impact of underground geological storage of H_2

Thesis subject

Hydrogen is considered as a source of renewable energy giving promising prospects and which would be able to complete fossil fuels in the near future. At the present time, the geological storage of H_2 remains very little studied despite of the specific behaviour of this gas (high reactivity and mobility). A better understanding of the mechanisms involved is therefore essential to improve the efficiency of this industrial process and better evaluate its economic viability and environmental impact.

A key point in the development of such technology is to characterize and constrain the processes that could affect (leakage through cap rocks) or alter (biotic degradation of H_2) qualitatively and quantitatively the resource within the storage framework in salt cavity or reservoir rocks. Particularly, bacterial activity is susceptible to produce methane (CH_4) or hydrogen sulfide (H_2S) to the detriment of H_2. Then, this project aims to:

- Characterise the potential leaks of H_2 by diffusion and permeation through salt rocks.
- Identify the main microbial phenomena able to alter the stored H_2 resource and quantify this mechanism.
- Give the data required for the modelling of these processes.

Permeability and diffusivity tests will be performed on cylindrical samples of halite under pressure/temperature/stresses conditions of deep geological storage to characterize these transport processes. Given the nanometric size of pores, a Klinkenberg effect is expected for the permeability whereas the Knudsen diffusion is supposed to predominate. From the measured data, modelling will be performed on a geometry representative of the halite microstructure to characterise the regimes of hydrogen migration through the cap rock.

In parallel, percolation tests (i.e., flow-through tests in triaxial mechanical cell) will also be performed on partially saturated cylindrical samples with the presence of hydrogenotrophic bacteria in order to identify the bacterial processes likely to promote the degradation of H_2.

The gas sampling at the output will be analysed by gas chromatography (GC) in order to quantify the consumption of hydrogen and potential production of annex gas (H_2S). At the end of percolation experiments, the final sample will be analysed by X-ray 3D nano-tomography to characterize the microscopic repartition of the fluid fraction inside the porous medium and eventually the 3D distribution of the biofilm. Post-experiment analyses (e.g., XRD, SEM, etc.) will also be performed to characterize potential neo-mineralizations, count bacteria and characterize the formation and growth of biofilms.

This work will be carried out inside the **GeoRessources** laboratory (« Hydrogeomechanics multi-scale » team, UMR 7359 - GeoRessources UL) and in collaboration with LCPME.

Required skills

Solid basis in transfers in porous media, reactive transport. The taste and interest for laboratory experimentations will be appreciated. Motivation and initiative, ability to work as part of a team.

Duration

3 years: from October 2017 to October 2020

Net salary (scholarship)

1500 € per month

Application deadline

May 31th 2017

Contacts

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Location

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References

Neveux L., Grgic D., Carpentier C., Pironon J., Truche L., Girard JP (2014) Experimental simulation of chemo-mechanical processes during deep burial diagenesis of carbonate rocks. Journal of Geophysical Research: Solid Earth 119

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