Reactive percolation experiments of the co-valorization of carbon dioxide geological storage through hydrogen production in ultramafic formations.

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The discovery of deep ocean smokers revealed the importance of hydrogen in the global mass balance between the upper mantle, the oceanic crust and the ocean, as well as its fundamental role in the deep ocean biosphere. Nowadays, hydrogen is also highly regarded as a potential replacement for fossil fuel in a growing number of applications. In parallel, the development of geological carbon dioxide storage technologies highlighted the potential of ultramafic formations as a recipient for CO2 mineralization due to their high reactivity (peridotite+CO2 = carbonates+silica), offering huge storage capacities, 10 to 100 times larger than the required amount for climate stabilization, and with no risk of leakage back to the surface. The combination of these two phenomena appears then as a natural development, allowing the offset of the carbonation costs in ultramafic formations by the production of clean and natural hydrogen fueling the energy transition, in a process where CO2-rich brine is injected in the formation and an H2-rich fluid is extracted from the other side

In this study, we present several reactive percolation experiments in natural serpentinite cores from the South-West Indian Oceanic Ridge, with fluids either NaCl-only or NaCl-NaHCO3 brine. The purpose was to analyze the influence of parameters such as temperature, pressure, inlet solution composition on the hydrogen production as well as the CO2 storage efficiency.

Results show that the carbonation leads to a fast and complete clogging of the cores by the precipitation of carbonates in the main percolation paths. On the contrary, NaCl-brine experiments presented a steady but much slower decrease in permeability. However, despite the fast clogging, carbonation extent reached interesting levels, e.g. 31% efficiency at 280°C and 200 bars. On the other hand, hydrogen production presents lower levels in the CO2 experiments than in the CO2-free experiments, highlighting competition between iron oxidation and its incorporation in the secondary phases.

These results will not only help understand the complicated coupling between hydrogen formation and CO2 storage in a potential industrial development of the technology, but also help describe the interplay of serpentinization and carbonation in natural settings such as mid-oceanic ridges or subduction zones.

Mots-Clés : Natural Hydrogen, CO2 sequestration, reactive percolation experiments, serpentinization

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