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Methodological considerations to assess biogeochemical reactivity during hydrogen storage in a carbonate aquifer

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Underground Hydrogen Storage (UHS) is emerging as a promising technology to enable large-scale and efficient storage of renewable energy, addressing the challenges of renewable energy intermittency and decarbonization. Carbonate host rocks, albeit representing one quarter of the potential UHS storage sites in Europe, have only recently started to receive attention in literature. One of the reasons being their potential increased reactivity compared to more inert sandstone host rocks and salt caverns. However, dynamics and kinetics of both geochemical and microbial reactions, and especially their relationship, remain unclear.
This study focuses on evaluating the effects of biogeochemical processes and their interplay on UHS in fractured carbonate saline aquifers, with a case study in Loenhout, Belgium. Low and high pressure batch reaction experiments are conducted to investigate the interactions between hydrogen, the natural brine, the subsurface microbial community, and mineral phases (pyrite-containing limestone) under reservoir-relevant conditions. This brings along unique challenges related to the extreme nature of the reservoir and the unique organisms that are found. Key parameters such as gas composition, microbial community composition and composition of the liquid phase are monitored to assess activity and its impact on UHS.
Preliminary results indicate low initial cell counts, with communities mainly comprising sulfate reducing bacteria, and slow kinetics for both growth and metabolic activity. For the geochemical experiments, the first results show no measurable activities. These findings provide valuable insights into the complex reaction dynamics of UHS in carbonate reservoirs.

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Belgium

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References

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