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CarbonStone: Experimental Insights into CO_2 Mineralization in Mafic Reservoirs for Climate Change Mitigation.

DR. PIERRE-ALEXANDRE TEBOUL[1], VALENTIN FORTIER[2], ALEXANDRA KLIMENKO[1], ENRIC SANTANACH-CARRERAS[1], PHILIPPE GOUZE[2], MARGUERITE GODARD[2], RICHARD LEPROVOST[2] AND SYLVAIN CALASSOU[3]

[1]TotalEnergies

[2]Géosciences Montpellier, CNRS, Univ. Montpellier

[3]R&D, TotalEnergies

Presenting Author: pierre-alexandre.teboul@totalenergies.com

The CarbonStone project focuses on CO_2 mineralization in mafic reservoirs as a large-scale industrial approach to reach Net Zero Emissions ambition and mitigate climate change. This relatively new carbon storage concept has been advanced by Carbfix, a leader in this field. Mineral carbonation is a natural process that occurs over geological timescales. It involves two stages: acidic CO_2-rich water dissolves Ca, Mg, and Fe-rich minerals, increasing ionic availability and raising the pH of the pore water. This triggers the precipitation of carbonate minerals at pH >6 (eq), storing carbon in a stable and permanent mineral form. The CarbonStone project aims to establish an offshore pilot program, combining CO_2 with seawater to minimize the impact of previous alteration of the basalts, to prevent any impact on potable water resources and to minimize the impact on land area footprint and societal risk.

Part of the project problematics are tackled using laboratory and numerical experiments. Critical issues to be addressed include:

- the sustainability of industrial injection of CO_2-enriched seawater into low temperature mafic rocks without major risks of reservoir clogging or passivation effect,
- linking fluid flow behavior in basaltic porous media (diffusive vs. advective) to the kinetics of dissolution and precipitation.

An experimental setup has been built to better understand reaction parameters at given temperature and pressure ranges and basaltic rock composition. This setup has been designed to better understand the spatial and temporal evolution of reactions through a single experiment using unique serialized slim-tube apparatuses. To define the best parameters for dynamic conditions, batch experiments were conducted coupled to PHREEQC numerical models. Concomitant microfluidic/Raman experiments using basaltic rock wafers provide direct information on passivation impact, as well as dissolution/mineralization.

This communication aims to present the early 2023/2024 results, including a review of the existing published experiments, the initial PHREEQC models and associated sensitivity analysis, primary discussions from batch experiments, and dynamic setup design. By combining cutting-edge experimental techniques with advanced numerical modeling, the CarbonStone project is poised to make significant contributions to our understanding of this possible industrial process.