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To cite this version:


HAL Id: hal-00634846
https://minesparis-psl.hal.science/hal-00634846
Submitted on 24 Oct 2011

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Both experimental study and numerical modelling of the effect of temperature gradient on CO₂ injection

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**CONCLUSION & PERSPECTIVES**

This problem is crucial as injectivity shall be maintained during the whole CO₂ injection and the combined approaches appear promising in this purpose. The developed experimental set-up will now be used to test various assemblages (cement, reservoir rocks, cap rocks, water composition, gas composition...). Greater analyses will help improve our numerical model and its ability to reproduce quantitatively experimental results and possibly allow upscaled predictions.

**CONTEXT**

CO₂ injection and underground storage obviously requires dealing with temperature differences between the injection well and the reservoir. For example, in Rousse-Lacq (french capture and storage project led by TOTAL) CO₂ is injected at 50°C in a gas depleted reservoir whose temperature is 150°C.

To assess this issue, an experimental set-up, COTAGES, has been designed and numerical simulations with the reaction/transport code HYTEC has also been performed to reproduce the observed behavior.

**NUMERICAL MODELLING USING HYTEC**

Temperature enhances both species transport and reactions kinetics, while CO₂ solubility also greatly decreases.

2D numerical simulations have been run with the following assumptions:

- purely diffusive transport (Oelkers & Helgeson 1988),
- kinetically controlled precipitation/dissolution (Kovac et al. 2006),
- aqueous reactions controlled by thermodynamics (www.ctdp.org).

**COTAGES EXPERIMENT PROTOCOL**

- Loading the reactor with 12 packets of 12.5 g each containing oolitic limestone
- Injecting solution (H₂O + NaCl 4 g/l)
- Heating up zone 3 up to 100°C
- Reaching steady-state (zone 2 = 55°C - zone 1 = 30°C)
- Injecting CO₂ in the cold zone

**AFTER 30 DAYS OF EXPOSURE**

Mass transfer between the intermediate zone (2) and the hot zone (3):

- HOT ZONE (3) : carbonates precipitation on the surface of grains and formation of aggregates
- INTERMEDIATE ZONE (2) : dissolution around grains and etch pits on the surface of oolites
- COLD ZONE (1) : weak loss of mass linked to moderate dissolution

**POSTER ID: GC31B-0876**