Effect of the injection well location on the CO2 storage in dome-shaped reservoir

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Introduction

The capture and storage of CO2 in deep geological formations is one of the proposed solutions to reduce anthropogenic CO2 emissions to the atmosphere. To be a reliable solution deep subsurface CO2 storage needs high retention rates. The efficiency and safety of the storage depends on which trapping mechanisms are dominant on each specific reservoir. Four trapping mechanisms (Figure 1) contribute to retention: structural (geological seals), capillary, solubility and mineral trapping.

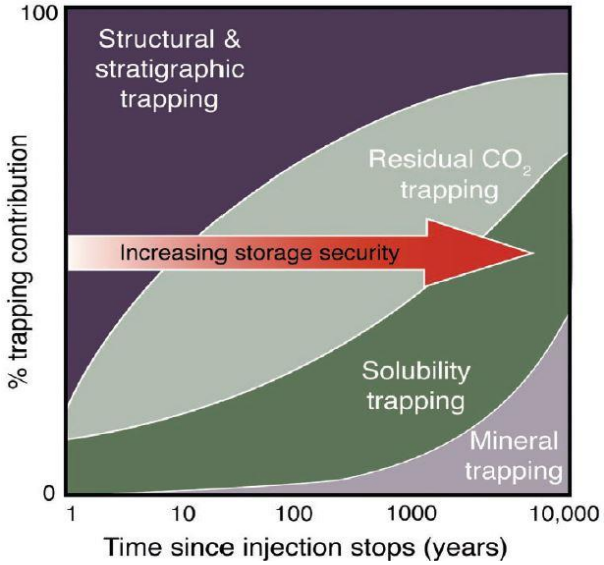

Figure 1 *Sketch of the temporal evolution of trapping mechanism. The physical processes of structural and residual trapping decrease with time, while the geochemical processes of solubility and mineralization increase. Figure taken from IPPC (2005) [1].*

The relevance of these mechanisms will vary with time due to CO2 migration, dissolution and reaction. The time evolution estimation of the mass of CO2 stored is an essential information in the pre-injection assessment of a geological storage. The aim of this study was to evaluate the influence of the injection point location on the evolution of the trapping mechanisms, quantifying the CO2 trapped in free phase, by capillarity and dissolved.

Model description

Storage quantification has been performed by using isothermal miscible multiphase flow simulations with COMSOL Multiphysics [2]. Three different injection locations have been tested in a dome shape reservoirs at a depth of 2.5 km, after an injection pulse of 0.3 Kg.s-1 during 150 days (Figure 2). The models simulate the fate of supercritical and dissolved CO2 during 100 years.

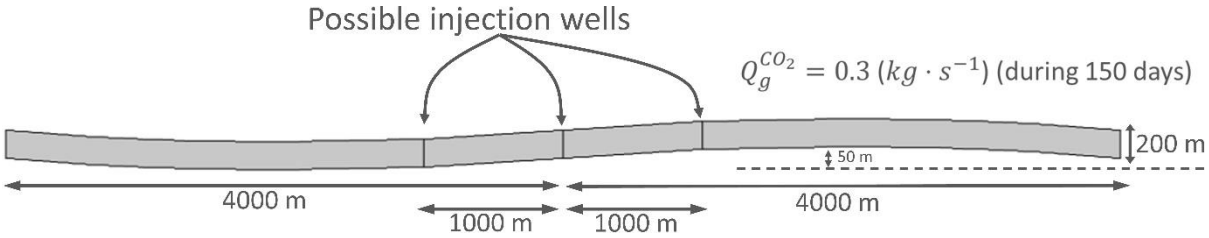

Figure 1 *Sketch of the reservoir structure targeted for the storage of supercritical CO2: 3 different potential locations of injection wells were evaluated by using numerical simulations.*

Results and conclusions

The model reproduces the fate of the supercritical CO2 plume and the onset of the formation of denser CO2-rich brine fingers, their extent and evolution (Figure 3). It is able to estimate the amount of CO2 trapped by each mechanism. It is thought that this type of model is a valuable tool to assess the efficiency of different injection regimes and locations.

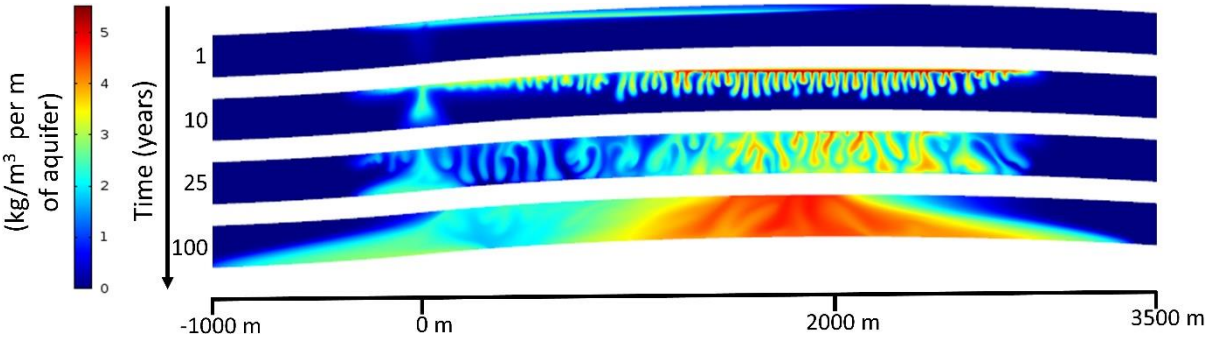

Figure 3 *4D evolution of the CO2 trapped by dissolution in the resident groundwater brine. The results correspond to the simulation for the well in the intermediate location (see Figure 2).*

The numerical simulations has shown that even small changes in the injection well location can lead to different distributions between trapping mechanisms. Injecting the CO2 far from the top of the storage formation, the migration of the supercritical plume becomes higher and 'fast' capillary trapping is enhanced; increasing the safety of the storage. Solubility trapping, however, is mostly a function of time, being almost independent of the injection location. Figure 4 shows the time evolution of the performance of different underground trapping mechanisms for the 3 studied locations of the injection wells.

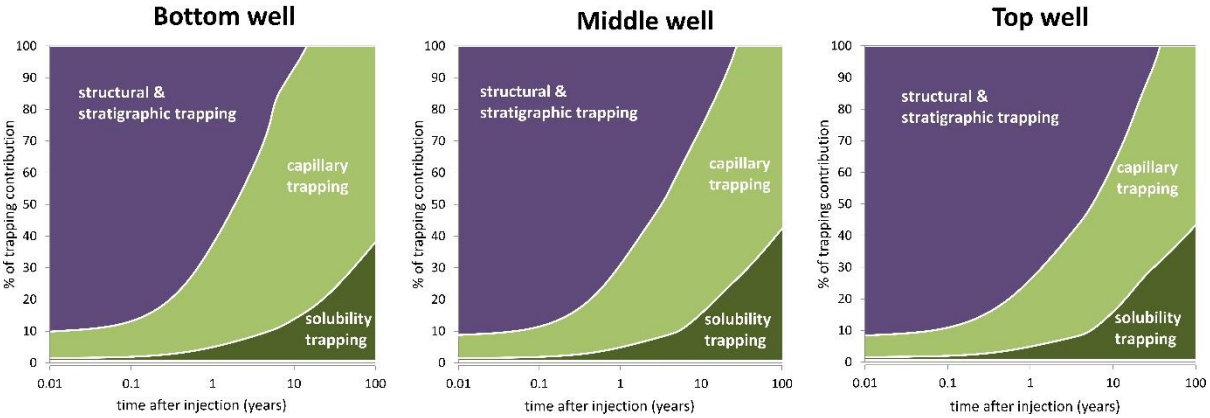

Figure 4 *Time evolution of the trapping mechanisms for the 3 different injection points.*

Acknowledgements

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References

[1] IPCC (2005) Underground geological storage. In: Metz B, Davidson O, de Coninck HC, Loos M, Meyer LA (eds) IPCC Special Report on Carbon Dioxide Capture and Storage, prepared by Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, USA, p. 195-276.

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