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Investigation of geochemical processes during CO2 injection using "push-pull" reactive tracer tests

Francesca De Gaspari (1,2), Jesús Carrera (2,3), Maarten Saaltink (1), Orlando Silva (2,3)

(1) (1) GHS, Department of Geotechnical Engineering and Geosciences, Universitat Politecnica de Catalunya, UPC-BarcelonaTech, Barcelona, Spain (francesca.de.gaspari@upc.edu), (2) GHS, Institute of Enviromental Assessment and Water Research (IDAEA), CSIC, Barcelona, Spain, (3) Energy City Foundation (CIUDEN), Spanish Government CO2 Geological Storage Programme

A single well injection-withdrawal, "push-pull", test is useful to obtain information on a wide variety of physical, biological and chemical aquifer characteristics. This test consists of injecting a solution, either reactive or not, into a well followed by an extraction from the same location. "Push-pull" tracer tests have been used to analyze processes of sorption, advection and dispersion during nonuniform flow, to evaluate longitudinal dispersivity and measure field-scale parameters such dispersion in a stratified aquifer or effective porosity. As regards the reactive "push-pull" tracer tests, from the analysis of the chemical composition of the extracted water it is possible not only to quantify the geochemical reactions occurring in the aquifer, but also to study the changes of the aquifer properties such as porosity and permeability. "Push-pull" test simulations were conducted to design the "push-pull" experiments to be held in Hontomín (north of Spain), a future pilot site for carbon sequestration, with the aim of characterizing the formation before starting the CO2 injection. Using the available geological data geochemical processes such as mineral dissolution/precipitation were modeled to observe their effects on the properties of the aquifer and potentially on the performance of the instrumentation in situ. Since "push-pull" tests have proven to be useful also to assess matrix diffusion of highly fractured rocks, both a single and a double porosity model were used to model the test, in order to simulate the behavior of a high porosity zone (reservoir, where advective processes dominate) and a low porosity region (caprock, mainly diffusive). The results suggest first that a double porosity model provide useful insights on the kinetic properties of geochemical processes, such as mineral dissolution/precipitation rate, and second that the matrix diffusion effects are appreciable and can be represented well with a multiple porosity model. Furthermore, the simulations indicate that a quite aggressive solution should be used to notice the effects of the injection. Thus an accurate analysis of the geochemical reactions would be useful also to evaluate possible damages on the well structure.