Abstracts:

Multi-scale modeling of coupled hydro-geochemical processes in porous and fractured reservoirs

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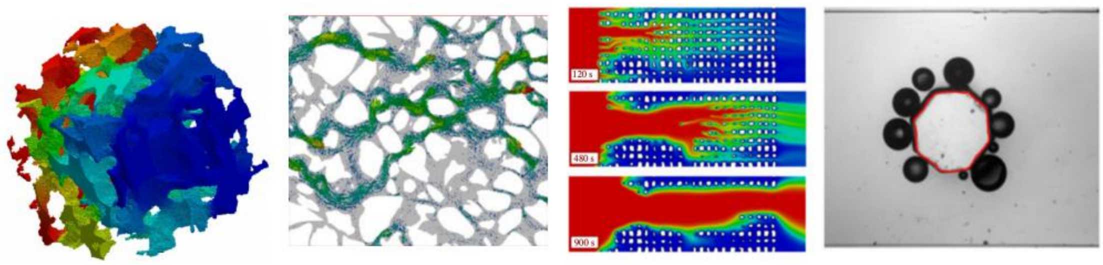
Effective use of the Earth subsurface for resources and energy applications requires very good control of time- and space-dependent fluid flow regimes. Such applications include the exploitation of groundwater reservoirs, the injection and sequestration of CO2 into deep saline aquifers, the storage of nuclear waste repositories, the development of geothermal energy, and the oil and gas recovery. Subsurface acidizing can lead to a reorganization of the pore-space through mineral dissolution and precipitation. These modifications of the rock's topology locally change the streamlines and, therefore, the hydraulic properties of rocks. The feedbacks between flow and geochemical reactions are complex and highly coupled. A good understanding of these non-linear phenomena is crucial to assess the long-term effectiveness and the environmental impact of such processes.

Pore-scale analysis of the involved physico-chemical processes is the elementary step in a modeling strategy in a cascade of scales nested in each other. Using devoted numerical modeling based on the micro-continuum approach[1,2,3], and microfluidic experiments[2], we highlighted and characterized several regimes of dissolution instability at the scale of individual grains. We then demonstrated that the presence of a gas phase produced from the dissolution of a calcite crystal changes the stability diagrams[4]. These results, upscaled to a continuum-scale formulation, inform the hydraulic and transport properties, and shed new light on the differences observed between lab and field measurements.



Reference:

[1]Soulaine and Tchelepi, *Micro-continuum approach for pore-scale simulation of subsurface processes*, Transport In Porous Media, 2016, 113, 431-456

[2]Soulaine, Roman, Kovscek and Tchelepi, *Mineral dissolution and wormholing from a pore-scale perspective*, Journal of Fluid Mechanics, 2017, 827, 457--483

[3]Soulaine, Creux and Tchelepi, *Micro-continuum framework for pore-scale multiphase fluid transport in shale formation*, Transport In Porous Media, 2019, 127 (1), 85-112

[4]Soulaine, Roman, Kovscek and Tchelepi, *Pore-scale modelling of multiphase reactive flow. Application to mineral dissolution with production of CO_2*, Journal of Fluid Mechanics, 2018, 855, 616–645

A multiscale approach to reaction-diffusion processes in domains with microstructure

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Reaction-diffusion processes occur in many materials with microstructure such as biological cells, steel or concrete. The main difficulty in modelling and simulating accurately such processes is to account for the fine microstructure of the material. One method of upscaling multiscale problems, which has proven reliable for obtaining feasible macroscopic models rigorously, is the method of periodic homogenisation.

The talk will give an introduction to multiscale modelling of physico-chemical mechanisms in domains with microstructure in the context of the method of periodic homogenisation. Moreover, certain aspects particularly relevant in upscaling reaction-diffusion processes in biological cells will be discussed together with their applications. If time permits very recent results on related problems in mechanics of solids will also be touched upon.