InterPore2021

Monday 31 May 2021 - Friday 04 June 2021

Book of Abstracts

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Reactive transport in porous media is of key importance in contaminant hydrology, carbon storage, enhanced oil recovery and chemical reactors engineering. Despite progress made in recent decades, measurement and prediction of the effective reaction rates is still not well understood. In this study we show how flow and transport heterogeneity affects the effective reaction rate. Our approach is based on a reactive transport particle tracking model at the continuum scale, in contrast to the pore-scale models which were successfully used to study the impact of heterogeneity on non-Fickian transport (Bijeljic et al., 2011, 2013) and reactive transport (Pereira Nunes et al., 2016). We make use of our reactive continuous time random walk (CTRW) model that was previously validated using Nuclear Magnetic Resonance (NMR) experimental measurements during dissolution of a Ketton carbonate rock core sample (Oliveira et al., 2021). The CTRW model is defined using a truncated power-law distribution of transit-time, which contains diffusive time cut-off, mean advective time, and a parameter β characterising the domains unresolved physical heterogeneities. To systematically study the effects of flow and transport heterogeneities on the effective reaction rates, we construct three domains with increasing physical and transport heterogeneity, and subject each domain to three different advective regimes with Pe = 20, 200 and 2000. This strategy allowed us to examine nine initial states. For transport, we characterize signatures of physical heterogeneity in the three porous media using velocity distributions and show how these imprints on the signatures of particle displacement, namely particle propagators distributions. In addition, we demonstrate the ability of our CTRW model to capture the impact of physical heterogeneity on the longitudinal dispersion coefficient over several orders of magnitude for a wide range of Pe defining transport regimes. Reactive transport simulations indicate that the effective reaction rates depend on (i) initial physical heterogeneity and (ii) transport conditions. We show that the higher the initial heterogeneity, the lower the reaction rate. Finally, a decrease in Pe would promote mixing by diffusion over advection, resulting in the higher reaction rates. Overall, we establish a framework to demonstrate and quantify the impact of physical heterogeneity on transport and effective reaction rates in porous media.

Time Block Preference:

Time Block C (18:00-21:00 CET) **References**:

Bijeljic, B., Mostaghimi, P., and Blunt, M. J. (2011). Signature of non-fickian solute transport in complex heterogeneous porous media. Physical Review Letters, 107(20):204502.

Bijeljic, B., Mostaghimi, P., and Blunt, M. J. (2013). Insights into non-Fickian solute transport in carbonates. Water Resources Research, 49(5):2714–2728.

Oliveira, R., Bijeljic, B., Blunt, M. J., Colbourne, A., Sederman, A. J., Mantle, M. D., and Gladden,L. F. (2021). A continuous time random walk approach to predict dissolution in porous media based on validation of experimental NMR data. Advances in Water Resources, page 103847.

Pereira Nunes, J. P., Bijeljic, B., and Blunt, M. J. (2016). Pore-space structure and average dissolution rates: A simulation study. Water Resources Research, 52(9):7198–7212.1 **Acceptance of Terms and Conditions**:

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MS3 / 112

Impact of Roughness on Multiphase Fracture Flow - Insights from 3D-Printed Fractures

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Fractures can provide principal fluid flow pathways in the Earth's crust, making them a critical feature influencing subsurface geoenergy applications, such as the storage of anthropogenic waste, emissions or energy. In such scenarios, fluid-conductive fault and fracture networks are synonymous with two-phase flow, due to the injection of an additional fluid (e.g. CO2) into an already saturated (e.g. brine) system. Predicting and modelling the resulting (partly-)immiscible fluid-fluid interactions, and the nature of fluid flow, on the field-scale, requires an understanding of the constitutive relationships (e.g. relative permeability and capillary pressure) governing fluid flow on the single-fracture scale. In addition to capillary and viscous forces, fracture relative permeability is influenced by aperture heterogeneity, arising from surface roughness. The degree to which surface roughness controls relative permeability behaviour in fractures remains unclear. As all fractures display roughness to various degrees, furthering our understanding of two-phase flow in fractures benefits from a systematic investigation into the impact of roughness on flow properties. To this end, we performed co-injection experiments on two 3D-printed (polymeric resin) fractures with different controlled and quantified surface roughness distributions (Joint Roughness Coefficients of 5 & 7). Brine and decane were simultaneously injected at a series of incrementally decreasing brine fractional flow rates (1, 0.75, 0.5, 0.25, and 0), at low total volumetric flow rates (0.015 mL/min). Steady-state fluid occupancy patterns, preferential flow pathways and overall fluid saturations in each fracture were imaged and compared using an environmental laboratory-based μ-CT scanner with a 5.8 μm voxel size (EMCT; Ghent University Centre for X-ray Computed Tomography). Experimental results highlight the importance of roughness on the relative permeability behaviour of fractures, which is, for example, a principal control on leakage rates from geological stores.

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Time Block A (09:00-12:00 CET) **References**:

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Impact of Wettability on Reservoir Quality Distribution and Preservation

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Time Block B (14:00-17:00 CET) **References**:

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