Geophysical Research Abstracts
Vol. 14, EGU2012-2873, 2012
EGU General Assembly 2012

Anomalous kinetics of reactive front in Porous Media

P. de Anna (1), A. M. Tartakovsky (2), T. Le Borgne (1), and M. Dentz (3)

(1) Geosciences, University of Rennes 1 / CNRS, Rennes, France., (2) PNNL, Richland, WA, United States., (3) Geosciences, IDAEA, Barcelona, Spain.

Natural flow fields in porous media display a complex spatio-temporal organization due to heterogeneous geological structures at different scales. This multiscale disorder implies anomalous transport properties (e.g. Berkowitz et al. RG 2006). Here, we show that it also implies anomalous mixing and reaction kinetics. This effect arises from pore scale, non Gaussian and correlated, velocity distributions.

We consider a reactive front, where a component A displaces a component B that saturates initially the porous domain. The reactive component C is produced at the front located at interface between the A and B domains. We investigate the effective kinetics for the mixing limited bimolecular reaction $A + B \rightarrow C$ in a $2D$ porous medium. The system is studied numerically via the SPH method.

While Fickian diffusion predicts a scaling of the cumulative mass of C as $t^{0.5}$ (e.g. Gramling et al. 2002), we observe that the temporal evolution of the cumulative mass of reaction product does not follow this classical law. Two temporal regimes are identified. At early times the invading solute is organized in fingers of high velocity. Reactions are fast and the mass product grows as t^2. At late times reactions slow down but still grow faster than Fickian case. We discuss the different scaling regimes arising depending on the dominant process that governs mixing.

In order to upscale these processes, we analyze the Lagrangian velocity properties, which are characterized by the non Gaussian distributions and long range temporal correlation. The main origin of these properties is the existence of very low velocity regions where solute particles can remain trapped for a long time and the channeling of flow in localized high velocity regions, which created finger-like structures in the concentration field.