Continuous Time Random Walk Analysis of Double Permeability Fractured Media

Jens Birkholzer and Andrea Cortis

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The objective of this work is to discuss transport phenomena in fractured aquifers where the hydraulic conductivity of the rock matrix may vary widely from almost impermeable (e.g., granites) to somewhat permeable (e.g., porous sandstone). In the first case, molecular diffusion would be the only transport process causing the transfer of contaminants between the well-connected fractures and the matrix blocks. In the second case, local as well as regional pressure gradients would force additional solute transfer between fractures and matrix, with considerable impact on measured breakthrough curves. Using a detailed discrete representation of fractures and matrix, we have conducted several numerical tracer experiments for various flow conditions and widely different rock matrix properties.

Breakthrough curves calculated at several locations in the fractured domain are analyzed by means of the Continuous Time Random Walk Theory (CTRW). In this framework, the interaction between the fractured and the porous rock domains is modeled by a transition time probability distribution function (pdf), $\psi(t)$. This pdf is defined as the generalized convolution of two distinct components: one related to the complexity of the fracture network characteristics (fast transport), $\psi_0(t)$, and a second one which defines the retention of the tracer in the porous matrix (slow transport), $\phi(t|(t-t'))$.

A parametric study of the evolution of the CTRW parameters describing transport as a function of the permeability of the rock matrix is presented here.