Upscaling transport in complex geological domains

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Abstract

Solute transport is known to be sensitive to both small-scale and large-scale geological features. While unified theoretical frameworks have been advanced in the last 10 years to model transport with a high degree of universality, I propose to model transport more contextually on the basis of highly resolved numerical simulations. The objective is to include the effect of realistic flow structures into a global upscaled transport model. Such a contextual upscaling heavily relies on the development of high-performance simulation methods coping with finely resolved and yet large domains.

Two examples in fractured and porous media will illustrate the effects of domain complexity and hydraulic conductivity variability on the numerical methods and upscaling results. Optimization of numerical methods involves the modification of discretization schemes and the use of parallel computing. Numerical simulations performed both on multi-scale fracture networks and on highly heterogeneous Gaussian correlated permeability fields show that upscaled transport can be modeled by mobile and immobile zones in interaction. Specification of the transfer rates and zone characteristics does however strongly depend on the heterogeneity structure and on the type of transport modeled (inert or reactive).