Transport in strongly heterogeneous porous formations: Anomalous transport and validity of the First-Order solution

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Transport of a nonreactive solute in natural aquifer is deeply influenced by the spatial distribution of the hydraulic conductivity *K*, in particular when in presence of strongly heterogeneous aquifers. We analyze here a few features of transport in such formations by recent theoretical advancements as well as accurate three-dimensional numerical simulations. We examine the impact of permeability structures on the Breakthrough Curve (BTC) of solute, at a distance *x* from the injection plane, under mean uniform flow of mean velocity *U*. The hydraulic conductivity *K* is modeled as a space random function, resulting in spatially variable velocity and concentration fields. The theoretical and numerical results permit to test and discuss a series of transport features which occur in strongly heterogeneous aquifers, like for instance the BTC tailing, connectivity and the occurrence of anomalous transport. The validity of the classic first order solution, formally valid for small variability of *K*, is also tested through a series of three-dimensional numerical simulations. It is seen that the first order solution is quite robust in predicting the BTC, providing a simple and effective solution to be employed in applications.

Keywords: Subsurface contamination, Breakthrough Curve, Stochastic subsurface hydrology

