Geophysical Research Abstracts,
Vol. 11, EGU2009-2940, 2009
EGU General Assembly 2009

A procedure for the upscaling of longitudinal dispersivity in strongly heterogeneous formations

A. Fiori (1) and I. Jankovic (2)

(1) Dept. of Civil Engineering, Università di Roma Tre, Rome, Italy (aldo@uniroma3.it), (2) Dept. of Civil, Structural and Environmental Engineering, SUNY, Buffalo, USA

Quantification of solute transport in heterogeneous aquifers is usually carried out by the spatial or temporal moments of the local concentration C. The heterogeneous medium is characterized by a spatially variable logpermeability Y(**x**)=ln K(**x**), which is often modeled as a space random function where Y is characterized by the mean $< Y >$=lnK_G, variance σ_Y^2 and linear integral scale I_Y. As a consequence, local concentration and its moments are also random. Transport is solved generally numerically by discretization of space by elements of scale L, usually much smaller than I_Y. The latter requirement may lead to considerable computational resources for three-dimensional problems, and for that reason larger values for L are often adopted. The upscaling problem consists in analyzing the relation between the small-scale and grid-scale logconductivities in order to obtain a reasonable approximation for C or its moments in the numerical grid. We solve the upscaling problem for the longitudinal macrodispersivity and the case of mean uniform flow and a thin planar plume of size much larger than I_Y. The model we adopt is based on the representation of the heterogeneous medium as a collection of independent blocks of random conductivity. Flow and transport are solved in a semi-analytical form by the embedding matrix approximation. Our results indicate that upscaling causes smoothing of conductivity spatial variations at scales smaller than that of discretization blocks. This results in a reduction of rate of spreading of solutes as quantified by the longitudinal equivalent macrodispersivity. In order to correct for this loss, a fictitious upscaling induced macrodispersivity is introduced. It is determined quantitatively for mean uniform flow, simplified formation structure and approximate solutions of flow and transport obtained in the past. It is found that the value of the induced longitudinal macrodispersivity is enhanced by high degree of heterogeneity.