Geophysical Research Abstracts
Vol. 19, EGU2017-5125, 2017
EGU General Assembly 2017

The "universal" behavior of the Breakthrough Curve in 3D aquifer transport and the validity of the First-Order solution

Igor Jankovic (1), Mahdi Maghrebi (1), Aldo Fiori (2), Antonio Zarlenga (2), and Gedeon Dagan (3)

(1) State University of New York at Buffalo, Dept of Civil, Structural and Environmental Engineering, Buffalo, USA, (2) Roma Tre University, Dept of Engineering, Roma, Italy, (3) Tel Aviv University, Faculty of Engineering, Tel Aviv, Israel

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 study is carried out through accurate 3D numerical simulations, rather than the 2D models adopted in most of previous works. All structures share the same univariate distribution of the logconductivity $Y = \ln K$ and autocorrelation function ρ_Y, but differ in higher order statistics. The main finding is that the BTC of ergodic plumes for the different examined structures is quite robust, displaying a seemingly "universal" behavior. The result is in variance with similar analyses carried out in the past for 2D permeability structures. The basic parameters (i.e. the geometric mean, the logconductivity variance σ_Y^2 and the horizontal integral scale I) have to be identified from field data (e.g. core analysis, pumping test or other methods). However, prediction requires the knowledge of U, and the results suggest that improvement of the BTC prediction in applications can be achieved by independent estimates of the mean velocity U, e.g. by pumping tests, rather than attempting to characterize the permeability structure beyond its second-order characterization. The BTC prediction made by the Inverse Gaussian (IG) distribution, adopting the macrodispersion coefficient estimated by the First Order approximation $\alpha_L = \sigma_Y^2 I$, is also quite robust, providing a simple and effective solution to be employed in applications. The consequences of the latter result are further explored by modeling the mass distribution that occurred at the MADE-1 natural gradient experiment, for which we show that most of the plume features are adequately captured by the simple First Order approach.