Geophysical Research Abstracts
Vol. 13, EGU2011-6103, 2011
EGU General Assembly 2011

Visualizing mixing in reconstructed heterogeneous aquifers

Eduardo Castro (1), Daniel Fernandez-Garcia (1), Diogo Bolster (2), and Jesus Carrera (3)

(1) Universidad Politecnica de Catalunya, Enginyeria del Terreny, Barcelona, Spain (daniel.fernandez.g@upc.edu), (2) Department of Civil Engineering and Geological Sciences, University of Notre Dame, Indiana, USA, (3) CSIC, IDAEA, GHS, Inst Environm Assessment & Water Res, Barcelona, Spain

Proper characterization of the mixing processes occurring in the subsurface is crucial for describing a large variety of geochemical problems, including cave formation, calcite precipitation and dolomization, chemical speciation and microbial reactions among others. Several measures of mixing can be found in the literature. When transport can be fully defined in terms of conservative components, i.e. when for example all reactions are locally instantaneous and the governing transport equation of all solute species is based on an advection-dispersion equation (ADE), De Simoni et al. [2005] showed that the vector of reaction rates per unit volume of fluid is proportional to a measure of mixing that involves the gradients of concentrations of conservative components and local dispersion. In real field settings, the gradients of concentrations involved in the definition of mixing are highly influenced by the natural variability of the aquifer properties. The erratic velocity fields typically obtained in natural aquifers produce highly distorted solute plumes that enhance mixing. The relationship between physical heterogeneity and mixing is still quite unknown. A promising method for understanding mixing is tracer visualization at high spatial and temporal resolutions. The methodology consists in visually inspect the behavior of an optical tracer injected into a porous medium. Full picture of the solute distribution is obtained by analyzing the relationship between pixel intensity and tracer concentration in time and space. The problem of these techniques is that the contour and geometry of the porous media, light fluctuation, and brightness variations due to non uniform light among others produce noisy estimates of concentrations that cannot be used to directly estimate mixing. We present a methodology to visualize local values of mixing from noisy images of optical tracers based on an iterative nonparametric local regression technique. The methodology is used to provide a full depiction of the local mixing processes occurring in a heterogeneously packed sand box aquifer, consisting in sharp interfaces of two sand materials with contrasting hydraulic properties.