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Spatial heterogeneity at laboratory scale: A corner stone in modeling contaminant transport in porous media

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A b s t r a c t

Modeling and computer simulation of contaminant transport has a long lasting history in groundwater hydrology. Various geo-hydrologists made an extensive effort to model and mimic the dynamics of both flow and contaminant transport in porous media. However, the unique feature of such efforts is the lack of proper justification concerning the mismatch obtained via comparing observed and simulated breakthrough curves. The current study is conducted under highly controlled experimental setup in uniform soil to enhance and better explain the rationality behind the failure emerging from reproduction of breakthrough curves by advection-dispersion equation (ADE) model. As the breakthrough curves obtained from the laboratory cannot be denied, it seems scientists should revise and perhaps revisit the ADE model for a better performance.
Keywords: Contaminant Transport, Sand-Box Model, Tracer Test, Pulse Injection, ADE Solution

١. INTRODUCTION

The fate and movement of dissolved substances in soils and groundwater has generated considerable interest to better manage the quality of the subsurface environment. The characteristics of solutes over relatively long spatial and temporal scales have to be assessed with the help of theoretical models as it is simply impossible to carry out experimental studies over sufficiently long distances and/or time periods. Mathematical models are often used to predict solute concentrations before management strategies are implemented. Advances in software and hardware now permit the simulation of subsurface transport using sophisticated mathematical models. Unfortunately, it is generally difficult to obtain reliable values for transport parameters such as the pore-water velocity, the retardation factor, the dispersion coefficient, and degradation or production parameters [١].

Laboratory sand-boxes are an important academic apparatus in the study of contaminant transport in porous media [٢]. Traditionally, dispersion experiments were implemented in small size column test, as summarized by, e.g., Bear [٣]. Utilizing sand-boxes set aside more capacity of producing soil structures with statistical properties similar to those found in nature. Employment of such sand-box in highly controlled laboratory tests is vital in ascertaining the limitations of method implemented in actual settings. Here experimental conditions are well defined and concentration and other data are much more accessible than in the field. Most published results fail to present the full evolution of the solute concentration is a common problem [٤]. Consequently, quantification of the full evolution of the contaminant, particularly after peak tail (receding limb), should be recorded and studied in some detail as the signature is not symmetric. In this research, salt tracer transport conducted in uniform porous media to enhance our understanding of contaminat transport in porous media. The current report presents and documents the results obtained from very recent laboratory experimentations. Point contaminant movement for three different flow rates is monitored and then the observed data is utilized to evaluate the quality of results obtained from the analytical advection-dispersion equation.