A Dual Continuum Model for Groundwater Flow in Karst Aquifers

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Abstract

In karst terrain, the interaction between the fast moving, highly turbulent conduit flow and the slow moving, laminar flow through porous media is largely unknown. Yet the dual nature of the karst system impacts the residence time of solutes in the groundwater supplies of over 25% of the world's population. This project attempts to address the need for a better understanding of the dual flow patterns in karst aquifer systems. Because of the highly disparate nature of the two flow regimes, a dual-continuum model was produced to predict storage in porous media as a result of the increased flow due to storm events. COMSOL Multiphysics® software and the COMSOL CFD Module were utilized to compute the steady state flow field for the aquifer coupled with the transient advection dispersion equation for solute transport. The model was developed as a staged solution in that it solves for the steady state velocity and pressure fields and then uses these fields as inputs for the second stage solution of the advection dispersion equation describing contaminant transport. The steady state velocity field is depicted in Figure 1. Initial testing of the model demonstrates that it is capable of modeling a wide variety of karst tracer response behavior ranging from near Gaussian or symmetric responses to bimodal responses.

Reference

Amiri, A., and Vafai, K., “Transient Analysis of Incompressible Flow Through a Packed Bed.” International Journal of Heat and Mass Transfer, vol 41, pp. 4250 – 4279 (1998).

Figures used in the abstract

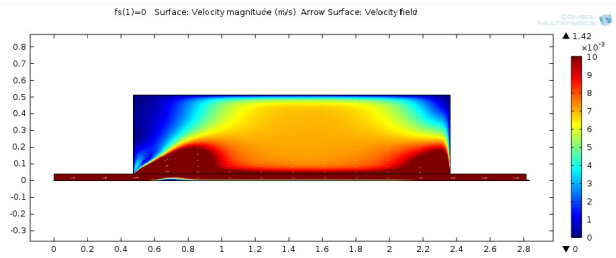

Figure 1: The steady state velocity field.