Investigation of contaminant transport in tidally-influenced porous media: experiment n and modeling

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Abstract

A one-dimensional homogeneous sand column is utilized to investigate the effect of tides on the concentration of groundwater contaminants discharging to a surface water body. Results of the column experiment are confirmed using a three-dimensional heterogeneous groundwater tank model. A constant water level is imposed upstream, and the downstream water level is controlled by a wave generator that controls the hydraulic head to mimic a semi-diurnal tidal fluctuation. The experimental results demonstrate that the tidal fluctuations in the downstream reservoir result in a decrease in average contaminant concentration at the point of groundwater discharge to the surface-water body. The further upstream the well is located, the smaller the amplitude of the concentration oscillation. In addition, upstream migration of concentration oscillations is observed in spite of a net downstream flow. As the classical groundwater flow and transport model cannot reproduce the phenomena we observed, an innovative model, multi-mobility model, is proposed with one highly mobile liquid phase, one less mobile liquid phase and a solid phase. Averaging theory is applied to develop the mass conservation equation from the microscale to the macroscale and facilitate the reduction of dimensionality to obtain one-dimensional governing equations with closure relations. A new finite volume method is utilized to solve the resulting equations. The simulation confirms the existence of the enhanced tidally-induced mixing process.

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