



Contaminant transport in dual-porosity media with depth-dependent reaction coefficients

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Predicting the fate of contaminant in subsurface is essential to assess and reduce the risk of soil pollution. It is generally accepted that the depth dependence often exists for the reaction processes of pollutants. In addition, heterogeneity is also a main issue in porous media, which will lead to non-uniform flow fields. In this study, we developed a one-dimensional mobile-mobile model for contaminant transport in subsurface with depth-dependent reaction coefficients. Two local systems at microscale level are involved in this model: a micro-pore system and a less permeable pore system. The breakthrough curves (BTCs) obtained from convection-dispersion equation (CDE) with depth-dependent are thoroughly analyzed, and the case with constant coefficients were compared as a reference. The effects of different parameters on BTCs were also studied. A sensitivity analysis was performed to illustrate the effects of adsorption coefficient and degradation coefficient on BTCs. It is demonstrated that the concentration profiles for depth-dependent reactions vary between the two extreme cases of no and constant reactions, depending on how fast the reactions cease with increasing depth. The velocity of slow domain (SVD) dominates the pattern of dual peak in BTCs, which tends to represent single peak when the velocity of SVD is small. We tested the applicability of the proposed model in the leaching experiments of both field herbicide and conservative tracer in an agricultural area of northeastern Greece, and compared the performance of our model and that of the CDE model of Gao et al. (2013), both of which have depth-dependent coefficients. The simulation results showed that the proposed mobile-mobile model with depth-dependent reaction coefficients was able to well capture the evolution of metolachlor concentration both in upper and lower depth.