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A mechanistic model for colloid and radionuclide co-transport in saturated porous systems: based on a two-site adsorption block mechanism

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The presence of colloids in groundwater can enhance radionuclides transport by loading on colloid to co-transport. The mechanism of co-transport is difficult to be fully revealed based on macroscopic experimental observations because the co-transport process cannot be monitored in situ. Hence a reliable model of colloid and nuclide co-transport is needed. Considering that colloid transport dominates the coupled transport in the process of co-transport, a finite difference model was constructed to describe the co-transport behavior of nuclide and colloid in saturated homogeneous porous media, focusing on colloid transport mechanism. The proposed model is formulated based on the assumption that the colloid transport is not affected by the presence of nuclides by ignoring the decay process of nuclides in a short period of time. The one-dimensional convection-dispersion transport of nuclides in porous media is coupled with the transport of nuclides attached to colloid as the pseudo-colloid. The adsorption and desorption processes (linear kinetic reactions) of nuclides on porous media and on mobile or filtered colloid are considered. The colloid transport model includes the reversible and irreversible adsorption of colloid on the host medium and the adsorption arrest process. With the assistant of the proposed model, the distribution ratio of nuclides as the free solute and colloidal attached states during co-transport was exploded, the related colloid driven transport mechanism was further elucidated, which would be helpful to predict the transport and retention risk of nuclides in porous media. The transmission model is validated by the comparison of calculated results with experimental co-transport results.

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