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Colloid-facilitated radionuclide transport through a bead-packed column and direct simulation using lattice-Boltzmann and random walk particle tracking

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It is well known that the radionuclide-carrying colloids in ground water can facilitate the transport of contaminants in the subsurface. A set of column experiments under physically and chemically heterogeneous conditions was conducted. Pore velocity was maintained below 100 cm/d and solution of CsI and silica colloids (1 micron diameter) was injected through saturated columns. At the same time, pore-scale simulation using lattice Boltzmann (LB) and random-walk particle tracking (RWPT) was used to solve the advection-diffusion equation (ADE) to match the breakthrough curves and dispersion coefficients of column experiment. With high-performance computing, we directly simulated flow and convective transport of non-adsorbing and adsorbing colloids in the entire column (L = 10.3 cm, D = 0.75 cm, resolved by 169 × 169 × 1722 voxels). We compared not only the dispersion coefficients, but also the breakthrough curves between column experiments and pore-scale simulations for the first time. The latter comparison was enabled by an algorithm that effectively maintained load balance and parallel efficiency.

References

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