**Modeling Colloid and Microorganism Transport and Release**

**With Transients in Solution Chemistry**

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**Abstract** – The transport and fate of colloids, microorganisms, and nanoparticles in subsurface environments is strongly influenced by transients in solution chemistry. A sophisticated dual-permeability transport model that is capable of simulating exponential, hyperexponential, uniform, and nonmonotonic retention profiles is modified and theory is developed to mechanistically account for the transport, retention, and release of colloids with transients in solution chemistry. In particular, colloid release in the model is directly related to the balance of applied hydrodynamic and resisting adhesive torques that determines the fraction of the solid surface area that contributes to colloid immobilization (*Sf*). The colloid sticking efficiency (α) and *Sf* are explicit functions of solution chemistry that determine the rates of colloid interaction with the solid, immobilization on the solid, colloid release from the solid and back into the bulk aqueous phase, and the maximum amount of colloid retention. The developed model is used to analyze experimental transport and release data with transients in ionic strength (IS) for 1.1 and 0.11 µm latex microspheres, *E. coli* D21g, and coliphage φX174. Comparison of experimental values of α(IS) and *Sf*(IS) with predictions based on mean interaction energies indicates that predictions need to account for the influence of physical and/or chemical heterogeneity on colloid interaction and immobilization. Furthermore, experimental values of *Sf*(IS) exhibited hysteresis with IS, especially for smaller colloids, due to microscopic heterogeneity. A sensitivity analysis indicates that colloid release with IS transients is not diffusion controlled, but rather occurs rapidly and with low levels of dispersion. The calibrated model provided a satisfactory description of the observed release behavior for a range of colloid types and sizes, and a solid theoretical foundation to develop predictions for the influence of solution chemistry on the transport, retention, and release of colloids.

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