Colloids, Deposits, and Clogging in Groundwater Remediation

University-Led Research

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This poster describes ongoing research (DE-SC0006962) aimed at linking colloidal phenomena and clogging in groundwater remediation. Colloids—particles between 1 nm and 10 μm—include bacteria, precipitates, and clay minerals that are ubiquitous in natural porous media. Soil science and filtration engineering indicate that colloidal phenomena (*i.e.*, colloid deposit morphology) can cause clogging that is detrimental for groundwater remediation. Can we avoid or manage clogging in groundwater remediation though better understanding of deposit morphology? To address this question, the current research comprises three components:

First, a series of laboratory experiments is being performed to simultaneously measure colloid accumulation, clogging, and deposit morphology. Here we report the first ever measurements of deposit morphology in flow cells, using a novel application of static light scattering in refractive index matched porous media (*i.e.*, Nafion) that quantifies deposit morphology as a fractal dimension. Details are given in the companion poster by Roth, Mont-Eton, and Mays. Ongoing experiments will measure how colloid accumulation, clogging, and deposit morphology vary over a range of physical (*i.e.*, fluid velocity) and chemical (*i.e.*, ionic strength) conditions.

Second, we have developed the first iteration of a clogging model that quantitatively accounts for the effect of deposit morphology. This clogging model is adapted from the literature on water treatment, in which a basic process is removal of colloid aggregates by settling, which provides a link between permeability and aggregate fractal dimension: Settling velocity depends on aggregate permeability, which in turn depends on fractal dimension. This new clogging model provides a framework for interpretation of the laboratory work above.

Third, we have planned a suite of measurements that will link the laboratory and modeling efforts with other research sponsored by the Department of Energy. Specifically, we plan to measure the fractal dimension of colloid suspensions taken from (1) laboratory experiments and (2) the Old Rifle field site. Task (1) links this work to ongoing research on chemical precipitation, x-ray computed microtomography, and nanogeochemistry. Task (2) links this work to conditions at the Old Rifle Integrated Field Research Challenge (IFRC) in Colorado.