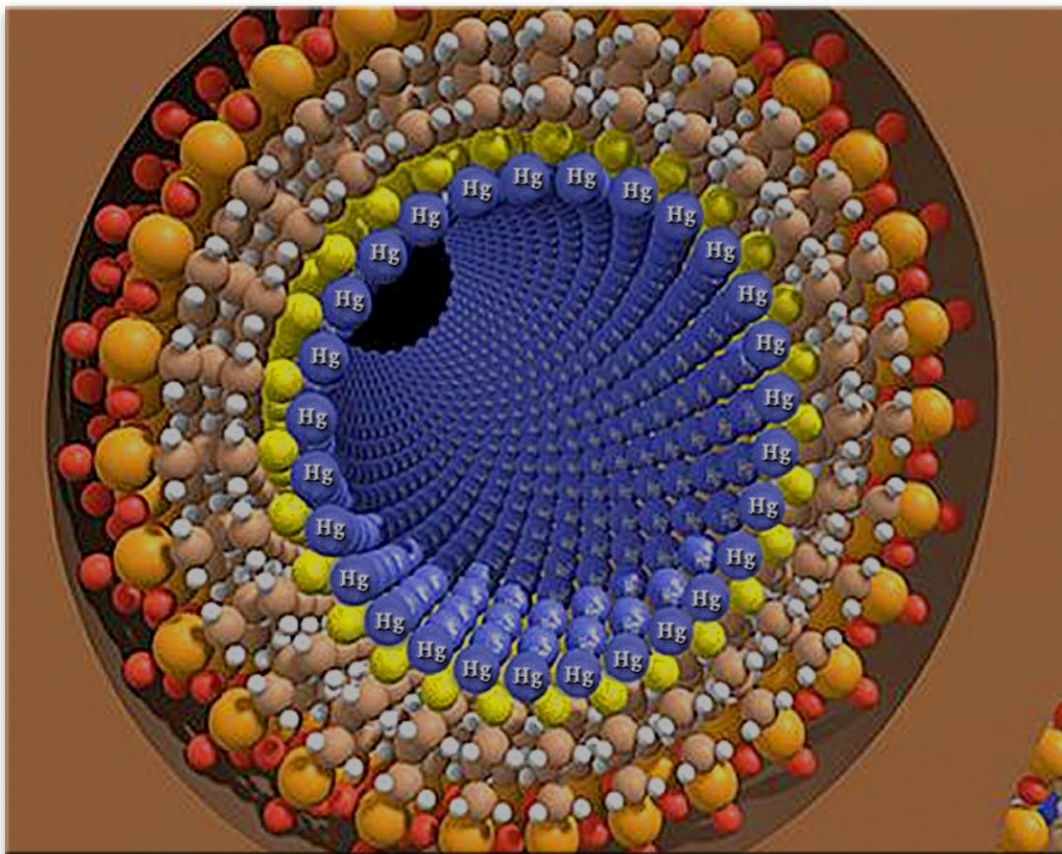


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Transport of Modified Reactive Nanoscale Iron Particles in Subsurface Soils
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There are several types of environmental remediation research being conducted at the University of Illinois at Chicago, one of which is the use of nanotechnology for the characterization and remediation of contaminated soils, sediments, and groundwater. The focus of this particular research is based on the hypothesis that transport (delivery) of reactive nanoscale iron particles (RNIP) into a contaminated subsurface is essential for the success of this remediation technology. Some challenges associated with the research include: (1) RNIP cannot be transported through porous media without modifying their surface; (2) the subsurface environment is mostly heterogeneous and can be unsaturated and/or saturated, making the delivery of RNIP under such complex conditions challenging; and (3) there is no general reliable predictive model for assessing the transport of RNIP into the subsurface.

The five objectives of this research are to investigate: (1) transport of various surface-modified RNIP (MRNIP) in different saturated homogeneous porous media; (2) transport of MRNIP in different unsaturated and saturated heterogeneous subsurface environments; (3) enhanced transport strategies; (4) reactivity of nanoscale iron particles during their transport in different subsurface environments; and (5) transport and fate modeling of nanoscale iron particles.

The scope of the preliminary research includes a series of column experiments using four types of RNIP and natural silty sand. The four types of RNIP, provided by TODA America, Inc., are their original RNIP (10 DS) and three polymer coated MRNIP. Properties of the RNIP suspension are: α -iron core and magnetite (iron oxide) shell composition; average particle size: 70 nanometers; 30 meters squared per gram of surface area; and 5,000 milligrams per kilogram sulfur content. The aqueous MRNIP slurry has a density of 1.20 grams per milliliter and is 17 percent solids.

The first step in the synthesis of RNIP (supplied by TODA America, Inc.) is acicular goethite (FeO(OH)), precipitated from oxygenated ferrous sulfate (FeSO₄) solution. Next, the acicular goethite is reduced to α -iron grains in a heated hydrogen gas atmosphere. The α -iron grains are wet-milled, a process during which the surface converts to magnetite.

The procedure for this research involved loading the columns with soil to a height of 20 cm, injecting a slug of selected RNIP suspension at 2.0 grams per liter (g/L), flushing with deionized water or simulated groundwater, and analyzing effluent for pH, electrical conductivity (EC), total dissolved solids, and iron. Among the different polymer MRNIP, MRNIP-2 was found to transport relatively better under both deionized water (DI) and simulated groundwater (electrolyte) flushing. Using MRNIP-2, a series of enhanced transport strategies were then tested, including various polymer to RNIP ratios, different levels of pressure and conditions (pulsed and constant), and oxygen-free conditions (oxygen was replaced with nitrogen).

Preliminary results show that polymer MRNIP, specifically MRNIP-2, can be effectively transported through subsurface soils under pressurized conditions. Results also show that enhanced transport strategies must be investigated depending on the specific soil type and the surface modification of RNIP.