Reactive Diffusive Transport Of Heavy Metals In Lake Coeur d'Alene Sediments

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Abstract

Lake Coeur d'Alene Basin, Idaho sediments have been heavily enriched with toxic metals, including Cd, Cu, Pb, and Zn, serving as a toxic, mutagenic and carcinogenic source of contaminants. Our focus is to develop a biotic/abiotic diffusive reactive transport model to evaluate the fate, transport, exposure and effects of zinc, lead, and copper in Lake Coeur d'Alene benthic sediments. The model is structured as a multicomponent reactive transport to simulate spatial and temporal distributions of metals in the benthic sediments and their effect on microbial consortia including multiple trophic groups and microbial populations in the benthic sediments. The 1-D inorganic diffusive transport model is coupled to a microbially-mediated redox reaction network which integrates syntrophic consortium biotransformation dynamics accounting for product and metal toxicity inhibition under a diffusive transport regime. The model simulates the mobilization of heavy metals initially sorbed onto hydrous ferric oxides through microbial reductive dissolution of Fe(III) minerals under redox disequilibrium conditions with simultaneous biogenic sulfide production, forming soluble metal (bi)sulfide complexes and insoluble metal sulfide minerals, and the effects of these metals on benthic microbial communities via accounting of dose, where dose is expressed in a novel fashion as a structural variable in the population dynamics of the microbial consortia.