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Diffusion-limited chromium reduction in soil aggregates

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Diffusion-limited chromium reduction in soil aggregates.

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Biogeochemical transformations of redox-sensitive chemicals in soils and sediments can be strongly transport-controlled and localized. These influences on chromium contamination of soils were tested through laboratory experiments on synthetic and natural soil aggregates. Micro-XANES maps of aggregate cross-sections were used to measure total Cr, Cr(VI), and Cr(III) concentration profiles. Reduction of Cr(VI) to Cr(III) occurred only within the surface layer of aggregates with higher available organic carbon and higher microbial respiration. Sharply terminated Cr diffusion fronts develop when the reduction rate increases rapidly with depth. The final state of such aggregates consists of a Cr-contaminated exterior, and an uncontaminated core, each having different microbial community compositions and activity. Analogous behavior may be expected for other redox-sensitive transformations in soils and sediments. In systems that support internal redox gradients, analyses of bulk chemical and microbiological conditions do not allow understanding of biogeochemical processes controlling the fate and transport of contaminants.