

Simultaneous Treatment of Heavy Metals and Chlorinated Solvents in Groundwater

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Background/Objectives. Treatment of groundwater contaminated with both heavy metals and chlorinated solvents can be challenging because the mechanisms operative in adsorption, precipitation, and coprecipitation of metals vary with the metal of concern. Further, treatments that perform well on metals may not be effective for degradation of chlorinated organic compounds. For example, certain alkaline reduction treatments that effectively remove hexavalent chromium may increase the solubility of arsenic, while having little impact on chlorinated organics. Similarly, a treatment based on enhanced reductive dechlorination, through biostimulation with organic carbon substrates, may effectively reduce chlorinated solvent concentrations but at the same time mobilize heavy metals by altering the oxidation reduction potential (ORP) and pH. The objective of this presentation is to promote a better understanding of the mechanisms involved in removal versus mobilization of heavy metals and degradation of chlorinated solvents and thereby promote good decision-making in selection of reagents and treatment methods.

Approach/Activities. The authors will review common approaches to treatment of heavy metals and chlorinated solvents from the perspectives of contaminant chemistry and site geochemistry. Performance data from comparative bench-scale testing, pilot-scale demonstration, and full-scale groundwater treatment will be presented and analyzed. The focus will be on results from commercial remediation projects where groundwater contaminated with both heavy metals and chlorinated solvents was remediated. The response to different reagents formulated with organic carbon, zero valent iron, iron oxides, iron sulfide, sulfate, and activated carbon will be compared.

Results/Lessons Learned. Precipitation of many soluble heavy metals as metal sulfides or iron-metal-sulfides can be promoted by ensuring an adequate supply of soluble iron and free sulfide under appropriate pH and Eh conditions. Soluble metals can also be removed by adsorption through direct addition of iron oxides or stimulation of biogenic iron oxide formation. Soluble organometallic compounds can be removed by adsorption to activated carbon particles. Minerals that mediate removal of metals can also support reductive dechlorination of organic compounds. The availability of sulfate, soluble iron, and metabolizable organic carbon are important factors that influence the extent of soluble metal removal and chlorinated solvent destruction. When appropriate biogeochemical conditions are created both contaminant groups can be simultaneously removed. Changes in pH and ORP that may be produced by the applied treatment should be considered when selecting a remediation method and designing its application. Mobilization of metals is most often observed when the applied treatment for chlorinated solvents results in acidification and a drop in ORP; however, this can be prevented by managing aqueous pH and ensuring adequate supplies of free sulfide and soluble iron.