Simultaneous Biogeochemical Treatment of Heavy Metals and Chlorinated Ethenes in Groundwater

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For over two decades, biological enhanced reductive dechlorination (ERD) and in situ chemical reduction (ISCR) have been applied to degrade chlorinated VOCs in groundwater. More recently, biogeochemical reduction (BGCR), a process that combines microbiological, chemical, and abiotic processes, has been employed to provide additional mechanisms to enable simultaneous degradation of cVOCs and sequestration of heavy metals. During BGCR highly reducing conditions are established to release ferrous iron (Fe^{2+}) from ferric minerals and ZVI and reduce sulfate to free sulfide (HS^-). The newly available Fe^{2+} and HS^- then combine to produce reactive iron-sulfide minerals such as pyrite which precipitate on the surfaces of aquifer solids. These reactive minerals mediate abiotic degradation of cVOCs. Further, the ZVI in biogeochemical reagents can undergo in-situ sulfidation, increasing its reactivity and extending its longevity. In addition to degrading cVOCs, when soluble iron and free sulfide concentrations are increased during BGCR heavy metals are removed by precipitation, coprecipitation, and adsorption reactions. The presentation will discuss the microbiological and chemical aspects of BGCR, and the reagents used to promote it. Results from full-scale application at a site where groundwater was contaminated with cVOCs, cadmium, nickel, and zinc indicate that BGCR can provide significant advantages for groundwater treatment.