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An Innovative Approach to Treatment of Heavy Metals in Soil and Groundwater Using Elemental Iron, Iron Sulfides, and Related Reactive Minerals

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Background/Objectives. High concentrations of heavy metals are found in many soil and sediment environments. At very high concentrations, heavy metals are known to create toxicity to microorganisms. Treatment approaches that rely on microbial process may not function well in an acutely toxic matrix because important processes such as carbon fermentation, oxygen consumption, and biological sulfate reduction can be significantly slowed or completely inhibited. The understanding of many metals removal mechanisms operative in soil and groundwater has advanced significantly over the past decade – thus, we are now in a better position to develop a new platform of effective metal remediation products.

Approach/Activities. In toxic environments, treatment reagents that do not depend entirely on microbial activity but rather combine reduction with adsorption and precipitation of heavy metals are advantageous. MetaFix™ reagents represent an entirely new family of products for treatment of soil, sediment, industrial wastes, and groundwater contaminated with heavy metals. Treatment mechanisms based on iron, iron sulfides, and other iron-bearing minerals have significant advantages due to lower solubility and greater stability of iron-bearing mineral precipitates formed with heavy metals. The new reagents enrich the aquifer with a mixture of reducing agents (ZVI, iron sulfides) and processed reactive minerals (iron oxides and iron oxyhydroxides). This new approach is insensitive to toxicity and can perform well even in environments that have high metals concentrations, high concentrations of organic contaminants such as solvents, high salt content, or pH levels (high or low) that would inhibit carbon fermentation and sulfate reduction.

The approach used is to create an effective blend of reducing agents, reactive minerals, mineral activators, catalysts, pH modifiers, and adsorbents for either ex situ or in situ applications. Dredge spoils containing high levels of TCLP/SPLP metals can be quickly treated and stabilized before final disposal. In situ reactive zones can be constructed to prevent migration of heavy metals into sediments or surface water. MetaFix reagents can also be directly delivered into sediments for in situ stabilization of heavy metals and thereby reduce exposure to aquatic life.

Results/Lessons Learned. The author will present a survey of materials and mechanisms as applied to treatment of a wide range of common heavy metal impacts found in soil and groundwater. Content will focus on the evolution of scientific concept through 2 years of bench-scale testing, followed by 1 year of field pilot and current full-scale application results in diverse geographies, including China and North America.