Risk and Stability of Phosphate-Immobilized Lead in Contaminated Urban Soil and Mining Sites in the Jasper County Superfund Site

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ABSTRACT

In situ application of soluble phosphates and organic matter is considered to be a cost-effective remediation technique for immobilizing lead (Pb) and other heavy metals and reducing health and ecological risks associated with contaminated soils. However, a long-term assessment of risk reduction induced by metal immobilization is needed to verify efficacy and gain regulatory and public acceptance of phosphate-based and organic matter-based remedial technologies. The study sites included a smelter-contaminated urban site, a mill-waste contaminated site, and a mining-waste contaminated site within the Jasper County Superfund Site, Southwestern Missouri. Field plots at the urban site were treated with phosphoric acid at a rate of 10 g kg^{-1} using surface application (SA), rototilling (RT), and pressure injection (PI); plots at the mill-waste site were treated with phosphoric acid at rates of 7.5 and 10 g kg^{-1} and incorporated using rototilling; plots at the mining-waste site were treated with different types of organic amendments, including biosolids and agricultural byproducts.

The parameters chosen to assess long-term risk reduction were: (1) metal bioavailability to organisms; (2) metal availability to plants (i.e., phytoavailability); (3) toxicity of treated soils to microorganisms; (4) phosphate and metal stability; and (5) solid phase P and Pb speciation assessed using microscopic, spectroscopic, and chemical fractionation techniques.

Results demonstrated that most of the phosphoric acid and OM treatments significantly reduced bioavailability, phytoavailability, and leachability of metals (Pb and Cd) in the contaminated soil. Analysis of P and Pb fractionation confirmed these reductions as well. In addition, most of treatments did not significantly impact toxicity in the soil to microorganisms. Thus, the in situ remediation of metal contaminated soil using phosphoric acid and OM is considered to be a practical remediation strategy with long-term benefits.