Treatability Testing for Effective In Situ Metals Immobilization at Complex Sites: Objectives, Methods, Results, and Lessons Learned from Vadose Zone Applications

Ravi Srirangam, P.E., Ph.D. and Alan Seech, Ph.D.
(Evonik, Parsippany, NJ, USA)

Background/Objectives. Remediation of heavy metals in subsurface environments can be challenging given their elemental nature and unique characteristics with respect to fate and transport. Based on the chemical properties of dissolved species, trace metals can broadly be classified into two distinct groups: reducible metals and metalloids (hexa, penta, and trivalent) or divalent metal cations. Metals of specific interest include chromium derived from industrial waste, arsenic present as part of historic fill or herbicide use and divalent metals from manufacturing sites. Metals treatment projects like these present significant technical challenges that can prevent common remedial approaches from meeting site objectives. Appropriate bench-scale treatability testing should be completed for these sites to identify the most effective remedial approaches to ensure effective in situ treatment and accelerated site closure.

Approach/Activities. The approach behind metals treatment is to convert soluble metals into insoluble precipitates or mineral complexes through promotion of physical, chemical, or biogeochemical processes and meet groundwater or soil remediation goals. Accordingly, various reagent blends that promote one or a combination of the above processes were used at multiple sites to address the metals of concern. A major focus has been the use of treatments that support removal of soluble metals as mineral precipitates including sulfides and iron sulfides. This approach helps to ensure long-term stability and of most heavy metal precipitates even when subjected to extreme changes in geochemical conditions. Treatability studies were designed with consideration of site geological, hydrogeological, and geochemical conditions and applicability of treatments to field-scale application. The results were used to establish proof of concept, select reagents, and design implementation methodologies consistent with future land use objectives.

Results/Lessons Learned. Results from bench-scale studies conducted over the past decade will be presented and discussed as relevant to field-scale implementation. Areas of focus include:

- high/low pH, alkalinity, and extreme redox conditions
- Synergistic effects of chemical and biogeochemical processes to complex metals
- Challenges with treating industrial wastes to meet TCLP as opposed to conventional soil and groundwater media.
- Potential toxicity of high metal (As) concentrations to biologically driven mechanisms.