3D Site Characterization and Autonomous Remedial Process Monitoring Using High Performance Electrical Resistivity and Induced Polarization Tomographic Imaging

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The electrical properties of the subsurface are sensitive to the hydrogeologic properties governing contaminant movement and to the geochemical processes functioning during contaminant transport or in situ remediation operations. Electrical resistivity tomography (ERT) and time-domain induced polarization (IP) tomography are methods of imaging subsurface electrical properties that have been extensively used for subsurface characterization and successfully demonstrated for monitoring contaminant distributions and remediation processes through time-lapse imaging. The primary reason for using time-lapse electrical imaging as a characterization and monitoring tool is that changes in subsurface properties are detected throughout the sensitive domain (i.e. in 2D or 3D as opposed to a point measurement).

Recent advancements in ERT and IP data collection hardware allow autonomous collection of large amounts of data over short periods of time, providing the potential to characterize and monitor at unprecedented spatial and temporal resolution. Realizing this potential requires 1), ERT and IP modeling and inversion codes capable of efficiently processing large data sets and 2), an understanding of the relationship between temporal and spatial changes in hydrogeologic and geochemical properties, and the corresponding changes in electrical properties.

We demonstrate how high performance ERT and IP data collection hardware and parallel inversion software are used in conjunction with point measurements to characterize the subsurface and monitor remedial progress in 3D at two field sites. The first site is a superfund site in Brandywine MD that was treated with a lactate amendment in the saturated zone to facilitate in situ enhanced bioremediation of a chlorinated solvent plume. The second site is in the unsaturated zone of the Hanford BC Cribs area which is currently undergoing a desiccation treatability test to evaluate the efficacy of using in situ soil desiccation to reduce contaminant flux to the water table.