Geophysics Tomography for Time-Lapse Mapping of In Situ STAR Thermal Remediation

Lais Muchatte Trento and ***Jason I. Gerhard (jgerhard@uwo.ca)*** (University of Western Ontario, London, ON, Canada)
Panagiotis Tsourlos (Aristotle University of Thessaloniki, Thessaloniki, Greece)
Michaye McMaster (Geosyntec Consultants, Inc., Guelph, ON, Canada)
Andrew Sims and Dave Liefl (Savron, Guelph, ON, Canada)
John Vidumsky (Dupont Corp, Wilmington, DE, USA)

Background/Objectives. Self-sustaining Treatment for Active Remediation (STAR) utilizes smoldering combustion to burn contaminants as fuel, destroying them in situ. Once started, no further energy input is necessary if air is continuously supplied, as the reaction spreads outwards from the ignition well in a self-sustained manner via the heat generated and transferred through the contaminated soil. The first full-scale STAR system was implemented at an industrial site contaminated with coal tar in Newark, New Jersey (USA). Comprehensive monitoring and validation data was collected during treatment (temperatures, captured combustion gases, and pre- and post-treatment TarGOST profiling and coring). However, as with all full-scale remediation applications, such data are relatively sparse and discrete in both space and time. This study evaluated the effectiveness of monitoring STAR by using time-lapse electrical resistivity tomography (ERT) under real field conditions. The study investigated the potential to map the spread rate and spatial extent of the treatment zone, visualize the air injected in the subsurface, and examine whether the propagating reaction could be tracked from the surface.

Approach/Activities. Two ERT studies were conducted during full-scale in situ STAR operation, one for a shallow (2.4 mbgs) and one for a deep (7.2 mbgs) treatment. In each case, two perpendicular surface lines of 36 stainless steel electrodes were installed at the surface. Resistivity surveys were conducted prior to STAR to evaluate geological units and to detect any interference from metal ignition points (IPs) and vapor extraction points (VEPs). During system operation in each case (approximately 9 days), 250 dipole-dipole ERT data sets (with 315 measurements each), once per hour, were obtained. ERT data processing was carried out using a relatively new time-lapse approach that eliminates artefacts, removes the background geology, and focuses on changes over time.

ults/Lessons Learned. In both studies, ERT provided insight into the rate and extent of processes occurring in the subsurface that could not be gained with traditional measurements. In the shallow treatment study, an ERT signal characteristic of the smouldering reaction was identified and mapped to show suspected coal tar treatment zones. In both studies, the evolving region of air-occupied soil as well as the vapour capture zones were visualized. As well, both studies mapped the reinvasion of groundwater after treatment had ceased. Quantitatively, the average subsurface resistivity correlated very well with other measures of treatment, such as total combustion gases collected. Overall, this research demonstrated that geophysics tomography has excellent potential as a tool for mapping subsurface thermal remediation.