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Characterization and Remediation Approaches for a Deep Subsurface Site: Hanford

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Background/Objectives. The Department of Energy (DOE) Office of Environmental Management represents one of the largest soil and groundwater cleanup programs in the world. Many sites have residual contamination at levels preventing them from reaching closure and can be described as complex, defined by: time to closure (50-100 years), difficult subsurface access, deep and/or thick zones of contamination, large areal extent, subsurface heterogeneities that limit the effectiveness of remediation strategies and approaches, as well as significant uncertainty with respect to understanding source distribution and contaminant behavior. As an example, the Hanford site is one of the most complex sites remaining for the DOE, due primarily to the radionuclide, inorganic, and metal comingled contamination found in the deep vadose zone (DVZ) of the sites' central plateau. Contamination in the DVZ is isolated from exposure such that direct contact is not a factor in risk to human health and the environment, however transport (flux, discharge) to groundwater creates the potential for exposure and risk to receptors. Understanding mechanisms or processes that impact transport of contaminants, thus limiting flux to groundwater is key for long-term management and groundwater protection.

There are significant natural attenuation processes inherent in vadose zone contaminant transport, including both hydrobiogeochemical processes that serve to retain contaminants within and physical processes that slow the vertical rate of movement. Studies over the past two years have focused on the risk-driving contaminants Tc, I, uranium, Cr, and nitrate. Biogeophysical and biogeochemical laboratory studies have focused on understanding the interaction of comingled contaminants on fate and transport mechanisms, as well as to identify potential remediation strategies that could be implemented in the DVZ. Most technologies are not well adapted for the complex conditions and waste streams found at the Hanford site.

Approach/Activities. Microbial characterization of core samples from the vadose zone and aquifer from across the Central Plateau will be discussed with respect to diversity and metabolic function. Microcosm studies have been set up using Ringgold sediments to enrich microbial communities for mixed contaminant transformation. Results show that microbes from the sediments can transform nitrate, iodate, Tc and uranium, using a variety of carbon sources. Radioiodine (I-129) is one of the primary risk drivers at Hanford and is present at levels above the drinking water standard of 1 pCi/L in two large plumes. A range of biogeochemical analyses have shown that microbes are present in the Hanford subsurface that transform different species of iodine through reductive and oxidative processes. Hanford isolates have also shown reduction of iodate under microaerobic and aerobic conditions. In these studies, iodate was transformed in parallel with nitrate, a co-contaminant in many plumes. Microbes have also demonstrate the ability to oxidize iodide to iodate and potentially organo-iodine compounds. Results from studies focused on Tc transformation and biogeophysical response data for chromium reduction studies will also be discussed.

Results/Lessons Learned. Collectively, this work directly supports the need for a better understanding of both current and historic contaminant fate and transport in the DVZ and bridges to the refinement of the site conceptual models, assessment of risk, and support for baseline risk assessment and remedy selection.