A Conceptual Model of Coupled Biogeochemical and Hydrogeological Processes Affected by *In Situ* Cr(VI) Bioreduction in Groundwater at Hanford 100H Site

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The overall objective of this presentation is to demonstrate a conceptual multiscale, multidomain model of coupling of biogeochemical and hydrogeological processes during bioremediation of Cr(VI) contaminated groundwater at Hanford 100H site. A slow release polylactate, Hydrogen Release Compound (HRC^{TM}), was injected in Hanford sediments to stimulate immobilization of Cr(VI). The HRC injection induced a 2-order-of-magnitude increase in biomass and the onset of reducing biogeochemical conditions [e.g., redox potential decreased from +240 to -130 mV and dissolved oxygen (DO) was completely removed]. A three-well system, comprised of an injection well and upgradient and downgradient monitoring wells, was used for conducting the *in situ* biostimulation, one regional flow (no-pumping) tracer test, and five pumping tests along with the Br-tracer injection. Field measurements were conducted using a Br ion-selective electrode and a multiparameter flow cell to collect hourly data on temperature, pH, redox potential, electrical conductivity, and DO. Groundwater sampling was conducted by pumping through specially designed borehole water samplers. Cross-borehole radar tomography and seismic measurements were carried out to assess the site background lithological heterogeneity and the migration pathways of HRC byproducts through groundwater after the HRC injection.

Several alternative approaches, including conventional and fractional advective dispersion equations and geostatistical analysis, were used to characterize hydraulic and biogeochemical transport parameters. The results of a joint inversion of cross-borehole geophysical tomography and flow-rate measurements in boreholes indicate the presence of a bimodal distribution of hydraulic conductivity for Hanford sediments. The Br-concentration double-peak BTCs curves indicate that HRC injection caused an increase in the tracer travel time (mainly in the low-permeability zone) over the period of observations of about 2 years. This increase in the Br travel time could be explained by the decrease in the saturated hydraulic conductivity caused by the formation of CO_2 and N_2 gases, growth of biofilms, and precipitation of calcite and insoluble Cr(III) complexes. All these processes are known to cause partial blocking of flow pathways within heterogeneous media, and slowing of mobile-immobile-region mass transfer. The analysis of geophysical data was also used to delineate the temporal variations of the zone affected by byproducts of bioremediation. Our results also indicate the importance of combining *in situ* hydrogeological, geochemical (including stable isotope analysis), and geophysical measurements with microbiological analytical analyses of water samples and sediments. These measurements can be used for obtaining data to control and simulate both enforced biostimulation and long-term natural attenuation of metals in groundwater.