Sequestering Uranium at the Hanford 200 Area Vadose Zone by in Situ Subsurface pH Manipulation Using NH_3 Gas

FIU's Applied Research Center (ARC) is supporting the U.S. Department of Energy's Hanford Site in developing a strategy to improve the efficiency of the uranium stabilization process through polyphosphate injection technology.

Characterization of vadose zone (VZ) soil at the 200 Area has identified a number of radiological and hazardous contaminants, including technetium and uranium. This work is focusing on long-lived uranium contamination, which is one of the key contaminants of concern that needs to be reduced to below levels that can cause harm to human health and the environment. Injection of reactive gases such as NH_3, is an innovative remediation technology shown to mitigate uranium contamination in soil. The injection of NH_3 gas causes ammonia gas dissolution in soil moisture, with the formation of NH_4OH and a subsequent increase in pH. This manipulation will significantly alter the pore water chemistry and affect the dissolution of silica and aluminosilicate from soil minerals, followed by co-precipitation of U(VI) [as uranyl (UO_2^{2+})] and Al at higher pH conditions. The main objective of the project is to evaluate the role of major pore water constituents such as Al, Si, bicarbonate and time on the formation of pure precipitates after NH_3 injection and to examine the solubility of formed minerals under environmental conditions relevant to the Hanford vadose zone. The batch experiments include preparation of a series of vials on synthetic fluids imitating contaminated pore water. The concentrations of major constituents including silicate, aluminate and bicarbonate are in the range reported for the Hanford VZ.

Objectives

- Evaluate the role of major pore water constituents such as Al, Si, bicarbonate and time on the formation of pure precipitates after NH_3 injection.
- Examine the solubility of formed minerals under environmental conditions relevant to the Hanford vadose zone.
- Conduct solubility studies over the pH range 6-11 in the presence of bicarbonate, calcium, and major pore water constituents.
- Conduct mineralogical and morphological characteristics by means of XRD, SEM-EDS to confirm the identity of the solid phase before and after solubility experiments.

Benefits

- Yields information on the formation and solubility behavior of minerals under environmentally relevant VZ conditions.
- Evaluates the effect of bicarbonate on the formation and solubility of minerals.
- Determines the effect of Al/Si on the formation of minerals.
- Determines the effect of multiple cationic and anionic species with a wide range of concentrations that could complex the hydrolysis and precipitation of radionuclides.

Figure 1. Experimental vials amended with U(VI).

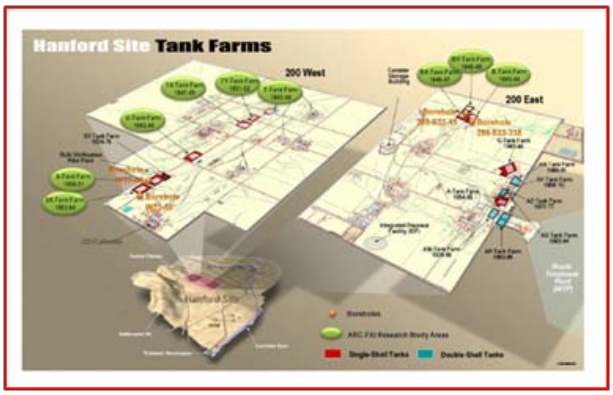

Figure 2. Hanford Site tank farms highlighting ARC-FIU research study areas.