Field Test of Vapor-Phase Ammonia Injection for Vadose Zone Remediation of Uranium

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Background/Objectives. Treatment to sequester inorganic contaminants in the vadose zone needs to consider effective means to deliver the treatment amendments. Geochemical manipulation is one approach for treatment by creating subsurface conditions that slow migration of inorganic contaminants. In the vadose zone, gas-phase delivery of ammonia vapor can be applied to induce sediment dissolution and precipitation processes that decrease the amount of mobile uranium in the vadose zone. Previous laboratory studies have quantified the decrease in uranium mobility caused by ammonia treatment and provided scale-up information.

Approach/Activities. Field testing was recently completed to demonstrate and quantify the effectiveness of ammonia delivery to the vadose zone. The field test at the Department of Energy Hanford Site was conducted to evaluate ammonia treatment as a means to sequester uranium and protect underlying groundwater. Approximately 3000 kg of ammonia were delivered to a 700 m^3 uranium-contaminated treatment zone. The subsurface distribution of injected ammonia was quantified using electrical resistivity tomography and in situ sensors to complement periodic gas sampling and analysis.

Results/Lessons Learned. Laboratory tests of samples from the field test site showed that mobile and immobile uranium compounds were present prior to treatment. Laboratory dosing of ammonia 1) increased the fraction of immobile uranium compounds and 2) decreased the rate and total amount of uranium leached from one-dimensional column tests. Field test information showed ammonia could be distributed in the subsurface and produce suitable conditions for the sequestration reactions, and reduced the uranium mobility at the test site. Field test results provide the technical information needed to evaluate the technology for application to uranium source treatment or for extrapolation to other potential applications of ammonia-based chemistry for remediation.