bonate or sediments that are acid soluble. These carbonate sediments may be byproducts of waste decomposition.

In situ identification of waste degradation can be accomplished by three approaches. Fluid and rock samples can be collected from within the injection plume by coring through the plume and collecting water and sediment samples for detection of microbes, wastes, and their byproducts, and for identification of mineral alteration by the waste. The injection well can be back-flowed to pull the waste to the point of injection for sampling, so that the degree of waste degradation can be tested. The sediments within the well can be analyzed to determine whether they represent chemical precipitates from waste decomposition within the well or from surrounding formations. The last approach is considered the most feasible and is presently being tested. Sediments from five wells are being analyzed chemically (inorganic, organic, X-ray analysis), biologically (lipid analysis and activity counts), petrographically (petrographic microscope and scanning electron microscope), and isotopically (carbon isotopes) to determine their source.

Treated waste/soil interactions and long-term metal mobility under acid rainwater leaching conditions

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Abstract

Column flow-through experiments have been conducted in which a treated municipal waste effluent has been reacted with two silty loam and two sandy loam soil samples having different TOC values, clay contents, and densities to study the attenuation of waste solution metals on soil columns. Reacted soil

columns were subsequently leached with synthetic acid rainwater to determine the long-term mobility of soil-attenuated metals.

Analysis of experimental effluent solutions by ICP emission spectroscopy and ion chromatography revealed three basic element (ion) concentration trends with time: (1) elements present at low levels in the treated waste solution (Al, Fe, Pb, Zn) were leached from the soil columns; (2) elements present at higher levels in the treated waste solution (Ba, Ca, K, Mn, Na, P, SO_4^{2-}) were strongly attenuated by the soil columns; (3) some elements present at moderate to high levels in the treated waste solution (Cl, F, NO_3^-, Si, Zn) showed mixed behavior with reaction time. Many element concentration trends displayed cyclical behavior, suggesting that several attenuation/leaching mechanisms were operational. Steady state conditions were reached for most dissolved element concentrations after 130–150 hours of experimental run time. Variations between experiments using different soil samples can be explained by the different organic contents, clay contents, and permeabilities of the soils.

In leaching experiments, a sharp increase in Al, Ba, Fe, and Zn was observed after 3–4 pore volumes of synthetic acid rainwater passed through the reacted soil columns. With continued leaching, aqueous metallic elements concentrations lowered. Boron and lead were leached at a much lower rate. Initial increases in effluent pH caused by hydrolysis of aluminosilicates in the soils were reversed with continued leaching. Although the levels of metals contributed to solution by synthetic acid rainwater leaching of these waste-reacted soil columns were quite low, the total metal content of the system was quite low. At higher system metal contents, however, the effluent pH trend suggests that metallic elements fairly immobile on a short-term basis may become increasingly mobile as continued leaching lowers the pH of the system.

These experiments have determined the interactions and mobilities of attenuated elements characteristic of a soil/municipal treated waste solution system. In the second half of the project, the soil attenuation and mobility of heavy metal elements will be studied by reacting treated municipal waste spiked with 10 mg/L concentrations of Co, Cr, Cu, Mo, Ni, Pb, and Zn with the silty and sandy loam soil samples, and subsequently leaching the loaded soil columns with synthetic acid rain.