Using Factor Analysis to Assess Bioremedation Efforts at a Contaminated Site in South America

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Background/Objectives. Chlorinated ethenes and halomethanes are common groundwater pollutants. The fate and transport of these compounds in situ are the net result of chemical, physical and biological forces. The relationships between these processes can be complicated making it difficult to identify key controllers of contaminant fate. At a site in South America, a biotreatment system consisting of electron donor addition has been in operation for over a decade to remediate groundwater contaminated with chlorinated ethenes and halomethanes. Over this time, the system has been subjected to three different management regimes. The monitoring dataset for the biotreatment system consists of aqueous groundwater concentrations of chlorinated ethenes and halomethanes as well as ancillary parameters (such as geochemical, nutrient and field data) covers over a decade of operation. To investigate the relationship between system management regime and treatment efficacy the data set was subjected to a statistical analysis via Positive Matrix Factorization (PMF).

Approach/Activities.

1) Organize and preprocess groundwater monitoring data to assemble PMF input matrices.
2) Apply PMF analysis on groundwater concentrations of each organohalide of interest.
3) Examine temporal and spatial trends of PMF model output for each organohalide contaminant class.
4) Investigate correlations between PMF outputs related to dehalogenation of site constituents of concern using available ancillary parameters such as geochemical, nutrient, and field data.
5) Assess bioremediation system efficacy and make recommendations regarding future management.

Results/Lessons Learned. This novel data mining approach has proven useful in interpreting groundwater monitoring data when provided a cohesive data set. The PMF analysis converged on a stable solution for all data sets and provided insights into the processes occurring in the subsurface. PMF was useful in characterizing different biotreatment locations and revealing biotic and abiotic reactions resulting in distinct fingerprints for each organohalide family explored in this work. Provided enough data on ancillary parameters that are indicative of redox conditions in the subsurface, correlating the PMF output with those parameters can suggest the conditions that are conducive to dehalogenation of the different classes of organohalides. Here, this data mining technique revealed conditions that are favorable for dehalogenation of chloroethenes and halomethanes. The advanced dehalogenation regime of chloroethenes was correlated with methanogenic conditions indicating that advanced dehalogenation of chloroethenes is most prevalent in highly reducing environments. The efficacy of management regimes was also explored and one of the regimes significantly affected the chloroethene degradation profile. Results also demonstrated that dehalogenation of halomethanse can occur under iron-reducing conditions and that elevated concentrations of these compounds inhibited chloroethene dehalogenation.