Multi-isotope (carbon and chlorine) analysis for fingerprinting and site characterization at a fractured bedrock aquifer contaminated by chlorinated ethenes

The use of compound specific multi-isotope approach (C and Cl) in the characterization of a chlorinated ethenes contaminated fractured aquifer allows the identification of several sources and contaminant plumes, as well as the occurrence of biodegradation and mixing processes. The study site is located in Spain with contamination resulting in groundwater concentrations of up to 50 mg/L of trichloroethene (TCE), the most abundant chlorinated ethene, and 7 mg/L of tetrachloroethene (PCE). The potential sources of contamination including abandoned barrels, an underground tank, and a disposal lagoon, showed a wide range in δ13C values from −15.6 to −40.5‰ for TCE and from −18.5 to −32.4‰ for PCE, allowing the use of isotope fingerprinting for tracing of the origin and migration of these contaminants in the aquifer. In contrast, there is no difference between the δ37Cl values for TCE in the contaminant sources, ranging from +0.53 to +0.66‰. Variations of δ37Cl and δ13C in the different contaminant plumes were used to investigate the role of biodegradation in groundwater. Moreover, the isotopic data were incorporated into a reactive transport model for determination of whether the isotope pattern observed downstream from the tank’s source could be explained by the simultaneous effect of mixing and biodegradation. The results demonstrate that a multi-isotope approach is a valuable tool for characterization of complex sites such as fractured bedrock aquifer contaminated by multiple sources, providing important information which can be used by consultants and site managers to prioritize and design more successful remediation strategies.

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