

Compound Specific Isotope Analysis (CSIA) as a Method to Verify Bioremediation of Chlorofluorocarbons at a Hazardous Waste Site

Jesse Manna (jesse.manna@mail.utoronto.ca), Axel Horst, Tetyana Gilevska, Georges Lacrampe-Couloume, Barbara Sherwood Lollar (University of Toronto, Toronto, ON, Canada) Sandra Dworatzek, Jennifer Webb (SiREM, Guelph, ON, Canada)

Background/Objectives. Contaminated sites can pose a threat to environmental health and safety. Development of a conceptual site model (CSM) for a contaminated site is an essential preliminary step towards design and implementation of a remediation plan. In addition to discovery and identification of contamination sources, site closure and remedial action plans require ongoing monitoring of multiple parameters including concentration levels of the contaminants of concern. Distinguishing concentration changes due to transport, dilution, or dispersion, however can be difficult to separate from decreases in concentration due to contaminant transformation and remediation without additional lines of evidence.

Approach/Activities. Compound specific isotope analysis (CSIA) can be used to meet the environmental forensic demand during the site assessment phase and can be used to validate the progression of biodegradation during a site remediation and eventual closure. For environmental forensic purposes, this may involve identifying whether different spills of the same contaminant have different isotopic signatures and therefore can be used as a line of evidence for source apportionment and identification. In addition, as has been shown for chlorinated solvents and petroleum hydrocarbons, biodegradation can be identified using CSIA. When organic contaminants are degrading, the ratio of stable isotopes may change due to the kinetic isotope effect. This is because microbes typically preferentially degrade bonds containing only the lighter isotope (e.g. ^{12}C) at a faster rate than bonds containing a heavy isotope (e.g. ^{13}C). Accordingly, the product of a degraded organic molecule would be expected to have a significantly different isotope signature than the reactant. Thus, monitoring the difference in the isotopic signature of a contaminant substrate versus its respective product, can not only identify but quantify the extent and rate of biodegradation. To date, however, these techniques have not been extended to an additional set of important pollutants, the chlorofluorohydrocarbons.

Results/Lessons Learned. 1,1,2 -Trichloro-1,2,2-trifluoroethane (CFC-113) is a very volatile and persistent chlorofluorocarbon that is still found at many hazardous waste sites and is a known ozone depleting substance (ODS). Experiments recently conducted by our team demonstrate that anaerobic dehalogenation of CFC-113 produces a large carbon isotope fractionation. Additional chlorofluorohydrocarbons are under investigation and this presentation will demonstrate the potential to use these carbon isotope signatures as an important line of evidence to document the effects of biodegradation at the field scale. A new method coupled with purge and trap gas chromatographic mass spectrometry referred to as '*peak cutting*' has improved detection limits of contaminants at concentrations typical of many waste hazardous sites. In addition, carbon isotope fractionation during volatilization was investigated to establish QA/QC for field sampling methods, sample handling and sample storage practices for CFCs.