

New developments in isotopic investigation of source and fate for halogenated hydrocarbon compounds at field sites: from groundwater to surface water to atmosphere

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The widespread use of chlorinated aromatic hydrocarbons has resulted in several hundreds of contaminated sites throughout North America. Their persistence and toxicity has led to an increased interest in the development of techniques to track and understand their fate in the environment. Recently, Compound Specific Stable Isotope Analysis (CSIA) has shown promise to distinguish between aerobic and anaerobic degradation of chlorinated aromatic hydrocarbons. To date, CSIA has mostly been applied to groundwater and in some cases to vadose zone studies, but the sediment water interface, a zone where contamination impacts surface waters (e.g., rivers, lakes) has been under-investigated to date. At this groundwater – sediment pore water interface, changes in hydrogeologic regime affect oxidation-reduction conditions and contaminant reaction mechanisms and hence the contaminant mass flux discharged to surface waters. Carbon isotope fractionation has been shown to be an important tool in identifying the effects of degradation and differentiating between different degradation mechanisms. To evaluate such changes in the field, a sampling technique allowing for a fine vertical resolution is required and can be achieved using passive diffusion (“peepers”) sediment pore water samplers. Results from the co-implementation of CSIA and peepers at a major contaminated field site will be presented.

Even less work has been done to date to apply CSIA to halogenated compounds such as chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC). Like the chlorinated aromatics these compounds have been widely used in society and industry. Specifically their historic use has been as refrigerants, propellants, solvents, foaming agents and are important intermediates in the production of anesthetics and other fluorinated compounds. Due to their ozone depletion potential production was banned for most uses under the Montreal Protocol and its amendments and atmospheric mixing ratios have started to decrease. In addition to the atmosphere, CFC and HCFC have been detected in groundwater, and emissions from various sources such as landfill sites is still ongoing. Previous studies have shown that both abiotic and biotic transformation of CFCs may occur under certain conditions but much remains unknown about the mechanisms and rates of *in situ* biodegradation. To investigate degradation that may take place in soils and groundwaters, a purge and trap method (P&T) has been developed to measure the stable carbon isotopic composition of CFC and HCFC extracted from waters. The initial results of a source differentiation study and the effects of volatilization will be discussed.