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# APPLICATIONS OF COMPOUND-SPECIFIC CARBON ISOTOPE RATIOS IN ORGANIC CONTAMINANT STUDIES

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Groundwater contamination, by organic compounds, is one of the major environmental problems in water resources today. Through interaction between groundwater and streams, lakes and wetlands, these contaminants can eventually impact surface water. Petroleum hydrocarbons and DNAPLS (Dense-non aqueous phase liquids) such as chlorinated solvents are the most common organic groundwater pollutants

The focus of the research on organic contaminant in groundwater has been on the behavior and fate of organics in the subsurface and remediation technology. The development of compound-specific isotope analysis on organic contaminants has opened new possibilities for the application of stable isotopes in groundwater research. The isotope approach has focussed on the evaluation of isotopic fingerprints in chlorinated solvents [1] and BTEX [2] and in the evaluation of isotopic fractionation associated with biotic and abiotic degradation of organic compounds [3, 4,5]. This paper will discuss recent advances on the application of compound-specific carbon isotope analysis in organic contaminant studies in groundwater. Analytical techniques will be discussed and laboratory and field isotope studies related to biodegradation of organic contaminants will be presented. Chlorinated solvents will be the primary focus.

It is expected that the area of major impact on the application of compound-specific isotope technology will be in the understanding of the attenuation of organic compounds in groundwater. There is a need for new tools to evaluate the efficiency of remediation technologies and the process of natural attenuation of contaminants in groundwater. These applications are based on the expected isotopic fractionation associated with degradation of organic compounds. Microcosm and field experiments are being carried out to evaluate isotopic patterns observed during degradation of organic compounds. No significant fractionation has been observed for degradation of BTEX under oxidizing conditions and reducing conditions [4]. However, abiotic and biotic degradation of chlorinated solvents is accompanied by a large isotopic fractionation [3, 6]. The following example illustrates the carbon isotope fractionation measured during biodegradation of TCE (Figure 1). This test was run using a bacteria consortium obtained from a TCE contaminated site. The largest isotope fractionation was observed during the dechlorination of cis-1,2-dichloroethene (cDCE) to vinyl chloride (VC) and VC to ethene. The $\delta^{13}C$ values for cDCE and VC increased from –30 to –10 ‰ and from –38 to +8 ‰, respectively. The $\delta^{13}C$ of the ethene changed from –60 to –30 ‰, the isotopic composition of the initial TCE. Similar carbon isotopic pattern has been observed on microcosm using cDCE and VC as initial compound [7]. This pattern has also been observed for PCE degradation under field and laboratory conditions [7]. These results and new developments of compound-specific deuterium analysis in organic compounds open new possibilities for the application of stable isotopes to assess natural attenuation of organic compounds in groundwater and remediation technologies.

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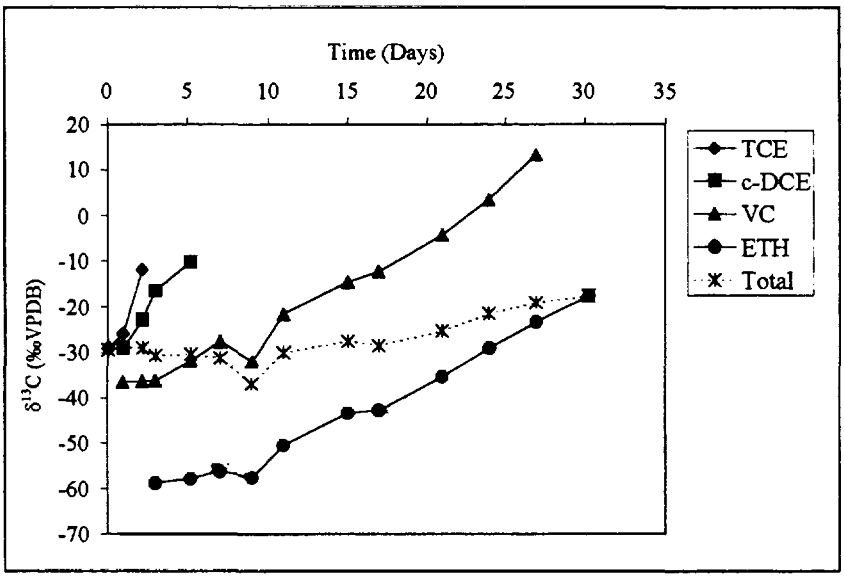

Figure 1. $\delta^{13}C$ patterns for TCE, cDCE, VC and ethene during biodegradation of TCE