

Use of Stable Carbon and Hydrogen Isotopes to Assess Biodegradation of Petroleum Hydrocarbons in Northern Environments

By

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The purpose of this study is to develop a technique capable of assessing the contribution of biodegradation to the natural attenuation of petroleum hydrocarbons in northern environments. Laboratory experiments have demonstrated that microbes indigenous to northern contaminated sites have the ability to degrade an array of petroleum hydrocarbons. However, demonstration of biodegradation at northern sites remains difficult due to the slow rates of biodegradation in these harsh environments.

In the mid-latitudes, stable isotopes have been shown to be a very effective indicator of the extent of biodegradation at field sites. Isotopic fractionation presents a novel technique for identifying biodegradation due to the preferential breakage of the ^{12}C -containing versus the ^{13}C -containing bonds during mineralization of contaminants. To date, there has been no study examining the extent to which arctic microorganisms exhibit isotopic fractionation of contaminants during biodegradation, and no study examining whether isotopic fractionation can resolve biodegradation in these environmentally important and fragile environments.

This project will measure carbon and hydrogen isotopic compositions of petroleum hydrocarbons in groundwater and soils at a contaminated sub-arctic site. This approach will quantify the extent to which decreases in concentration at the site are a function of biodegradation, versus simple mass loss due to transport processes such as advection, dispersion and dilution. Additional verification will be provided through microcosm experiments. After analyzing the isotopic data in conjunction with other hydrogeologic, geochemical, and biological data, it will be determined whether stable isotopes can confirm in-situ biodegradation.