In-Field Rapid Precipitation of Carbonate Minerals for Assessing Hydrocarbon Biodegradation Rates through Radiocarbon Apportionment

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Background /Objectives. The accidental release of hydrocarbons into the environment is a common source of soil and groundwater contamination around the world. In certain locations these contamination events are best mitigated through in situ biodegradation or natural source zone depletion (NSZD). NSZD is an appealing option for remote locations, low threat sites with minimal risk of human interaction, or ecologically sensitive environments where disturbance from active remediation is unacceptable. To determine the viability of NSZD for remediation, the attenuation rate of these contaminants must be quantified. This can be achieved by carbon dioxide (CO_2) efflux measurements coupled with analysis of the radiocarbon content of the CO_2 emissions from the impacted soil. Common practices for radiocarbon sampling are costly and time intensive, driving a need for a simpler, rapid approach.

Approach/Activities. The use of radiocarbon provides a two-end member system to apportion soil CO_2 emissions at contaminated sites between natural and contaminant sources. When CO_2 emissions attributed to a hydrocarbon source are paired with soil gas efflux measurements subsurface contaminant mass loss can be quantified. Current sampling techniques pose various logistical and financial hurdles due to intensive sample preparation. Here we present results of field tests at an arctic diesel fuel contaminated site in Old Crow, Yukon, Canada following the successful deployment of a new in-field method for rapid CO_2 extraction from soil gas. CO_2 is stripped from mixed soil gas and instantaneously precipitated as barium carbonate ($BaCO_3$) in small exetainers. Multiple samples can be collected in one day and require simple, compact sampling equipment. The stable $BaCO_3$ sample is easily transported to the laboratory as inert solid material and is ready for direct analysis by accelerator mass spectrometry (AMS) at the Lalonde AMS Laboratory, University of Ottawa. Background, plume proximal and plume centred samples are collected to show the range of isotopic variation across a site. Field blanks are prepared on site as well using acid digestion of a radiocarbon free carbonate material. Samples are normalized to a laboratory prepared modern CO_2 generated $BaCO_3$ sample.

Results/Lessons Learned. In a case study from a permafrost site in the northern Yukon, final radiocarbon results were obtained within one week of returning from the field, providing essential, timely information at low cost and reduced logistical challenges and field sampling time. Sampling in the first deployment of field work showed promising and highly reproduceable results. The sampling technique allows for field blanks to be produced on site along with sampling and initial studies saw low margins of error in sampling. Field sampling will continue in early September 2018 with a strong focus on duplication, sampling technique refinement and best safety practices for field deployment. Results will be presented to demonstrate the utility of this novel method for radiocarbon apportionment and NSZD rate estimation.