Comparison of ^{14}C isotope-based correction methods for quantifying petroleum hydrocarbon degradation rates

ANNE WOZNEY[1] IAN CLARK[2] AND K. ULRICH MAYER[3]

[1,] University of Ottawa, Canada (awozn019@uottawa.ca)
[2] University of Ottawa, Canada (idclark@uottawa.ca)
[3] University of British Columbia (umayer@eos.ubc.ca)

To implement monitored source zone natural attenuation (SZNA) at hydrocarbon contaminated sites, contaminant biodegradation rates must be quantified in order to estimate source zone longevity. Surficial CO_2 efflux surveys have recently been used to delineate hydrocarbon source zones and to provide estimates of hydrocarbon degradation rates. [1] This approach requires accurately distinguishing between petroleum-derived CO_2 respiration and background natural soil respiration. Radiocarbon can be used to quantify petroleum derived ^{14}C-depleted CO_2 efflux from background ^{14}C-enriched natural soil respiration[1]. However, a standard field method for radiocarbon sample collection has not been developed for CO_2 efflux surveys.

Detailed CO_2 efflux surveys were conducted using an LI-8100 dynamic flux chamber overlying LNAPL source zones at a historical pipeline rupture site. Survey flux and compositional gas results confirmed elevated CO_2 efflux at locations previously identified as contaminated. Four different field methods were used to obtain gas samples for ^{14}C isotopic analysis; including direct sampling from short-term dynamic flux chambers, long term static chambers, soil vapour probes and vadose zone monitoring wells. A ^{14}C correction for each method was applied to determine a petroleum-derived CO_2 efflux rate, and a method comparison was conducted. Results indicated that ^{14}C corrected fluxes from long term chambers closely correlate with ^{14}C corrected fluxes derived from subsurface measurements, while short term chambers had low sample yields and derived fluxes deviated greatly from other methods. Analysis showed that ^{14}C isotopes can be used effectively to determine the contribution of petroleum biodegradation to measured CO_2 efflux, therefore allowing the quantification of hydrocarbon degradation rates.

References

[1] Sihota and Mayer (2012) *Vadose Zone J* **11**, doi:10.2136/vzj2011.0204.