Distinguishing Noise from Signal in the Measurement of Natural Source Zone Depletion (NSZD) Rates at Petroleum Contaminated Sites

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Background/Objectives Light non-aqueous liquid (LNAPL) contaminated sites still make up a large portion of the world-wide environmental liabilities. While many remedial technologies are available to deal with these sites, biodegradation-mediated natural source zone depletion (NSZD) is gaining widespread use, both as a candidate remedy and as a reference to evaluate the efficiency of active remedies.

Natural source zone depletion (NSZD) has become a widely accepted remedial strategy for mid- to late-stage petroleum impacted sites. Several technical guidance documents, including API (2017) and ITRC (2018) address the implementation of NSZD and the importance of including NSZD processes in the development of site conceptual model for petroleum impacted locations. The availability of multiple methods to measure NSZD rates at field sites has been a major factor contributing to these developments. Most available methods measure NSZD rates as total contaminant mass losses based on mass or energy balances on biodegradation by-products (i.e., carbon dioxide or heat).

This presentation will address the different error sources on the application of multiple methods to measure natural source zone depletion (NSZD) rates. Best practices that help achieve a degree of measurement uncertainty commensurate with different measurement objectives will be discussed.

Approach/Activities Three examples will be discussed to illustrate sources of error due to temporal and special variations in the processes being measured: a) the use of background correction vs. a radiocarbon-based location specific correction for a mass balance method based on CO2 efflux measurements; b) the error sources from short-term vs. long term measurements based on CO2 efflux measurements; and c) the use of a background correction vs. a single stick method for a heat balance method. These examples will be illustrated with site data. Practices that help control different error sources will be discussed.

Results/Lessons Learned Among the different methods available, each method can control some error sources and is susceptible to others. Awareness of the specific traits of each method will allow practitioners to select methods compatible with the monitoring goals for each particular site and remedial stage combination.

Julio Zimbron

Dr. Zimbron's professional experience spans nearly two decades and includes two years of consulting service for Shepherd-Miller Inc., five years of industrial research at General Electric's Environmental Technologies Lab and GE Energy's coal gasification business, and five years of academic research at the Center for Contaminant Hydrology at Colorado State University.

While conducting the research that eventually led to the development of the Fossil Fuel Traps, Dr. Zimbron says a pivotal moment occurred when he began thinking about barometric pumping, the process by which daily variations in atmospheric pressure alter the amount of soil gas that flows through the subsurface."This made me realize that a one-time measurement of soil gas flux wouldn't be accurate — any sensible measurement would need to be a long-term average," he said. So he and his colleagues went to work designing the Fossil Fuel Trap to provide average soil gas flux values over an extended period (as opposed to an instantaneous "snapshot" in time) that had the potential of providing meaningful site characterization.

As founder and owner of E-Flux, Dr. Zimbron is dedicated to the idea of product simplicity — creating a technology and service that is cost-effective, easy to use, and provides repeatable and reliable data that meets the needs of the end user. "With its ease of use and data interpretation that everyone can understand, I like to say that the Fossil Fuel Traps make soil gas flux measurement accessible to all," says Dr. Zimbron.