

Integrating Theory and Practice to Better Understand and Apply NSZD at Field Sites

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Background/Objectives. Natural source zone depletion (NSZD) has emerged over the last decade as a viable alternative for restoration of LNAPL-impacted sites. The NSZD CSM continues to evolve, but some key questions remain open, for example: are NSZD rates different in the saturated and vadose zones; how do NSZD rates vary with LNAPL saturation and composition; and how do NSZD measurements inform progress toward regulatory criteria, which are typically compound-specific concentrations in soil and groundwater.

Approach/Activities. An extensive literature review and a two-year field study were undertaken to further the NSZD conceptual model. The literature review synthesized a multidisciplinary body of knowledge, including forensic chemistry, microbiology, hydrocarbon biodegradation, and other anaerobic systems, e.g., wetlands, landfills, peat, anaerobic digesters, etc. The field-work was designed to understand the spatiotemporal variability of NSZD. The ongoing work includes continuous NSZD rate measurements at a site using thermal monitoring at 16 locations that have different LNAPL architectures, saturations, and compositions; one NSZD location is in an area being treated by soil vapor extraction (SVE). These locations are characterized by CPT, ROST, gas-chromatography of soil samples, along with conventional stratigraphy logs, PID and FID. The continuous temperature response of NSZD processes also allows for an enhanced understanding of the effects of seasonal changes, rain, etc.

Results/Lessons Learned.

Literature review: The results of the literature review are published in Garg et al. 2017, but a select key points will be presented in this talk:

- Factors that may act as controls affecting methane generation and its measurement, e.g., acetate build-up, soil-moisture, episodic ebullition, etc.;
- Importance of direct outgassing as a key process, which is contrary to the common conceptualization where dissolution is necessary for biodegradation to occur;
- Based on Ng et al. (2014, 2015), a simple planning-level model where different LNAPL constituents follow first-order decay in a semi-sequential order, with a quasi-zero-order bulk NSZD rate.

Field work:

- On-going thermal monitoring indicates that NSZD rates at the site range from 150 - 1000 gal/acre/yr.
- Higher NSZD rates are observed in the SVE area
- Discussion of spatiotemporal variability in NSZD rates as a function of LNAPL composition, saturation, architecture and seasonal variability will also be presented (data analysis in progress).