A Laboratory Investigation of Dissolved Helium and Neon as Dense Nonaqueous Phase Liquid (DNAPL) Partitioning Tracers

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Abstract. Successful and cost-efficient groundwater remediation depends upon accurate characterization of contaminant mass and distribution; however, traditional site characterization methods rarely provide enough information to sufficiently characterize dense nonaqueous phase liquid (DNAPL) zones. Recent work has demonstrated that the partitioning interwell tracer test (PITT) can be used to locate and quantify subsurface DNAPL. The PITT involves an analysis of the average travel times of partitioning and conservative tracers through the test region. Average DNAPL saturation is estimated from the observed retardation of the partitioning tracer relative to the transport of the conservative tracer. Tracer partitioning is dependent upon the DNAPL-water partition coefficient and the DNAPL saturation.

Laboratory investigation indicates that dissolved helium and neon are appropriate partitioning tracer candidates for field-scale PITT application. Batch experiments determined the trichloroethene (TCE)-water equilibrium partition coefficients to be 2.40 ±0.18 for helium and 3.36 ±0.22 for neon. Column-scale PITTs were conducted in a well-sorted sand with TCE saturation ranging from 0.047 to 0.105. The average error in calculated TCE saturation was approximately 11% by direct integration of the tracer breakthrough curve (BTC) and 13% by fitting a dual-porosity transport model to the BTC. A sensitivity analysis indicates that low tracer detection limits are more important than tracer measurement precision, and that accurate characterization of the tail region of the BTC is particularly important.