

## **Spatial quantification of non-aqueous phase liquid (NAPL) contaminants in frozen soil cores using nuclear magnetic resonance (NMR)**

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**Abstract.** Resolving spatial variations in subsurface contaminant concentrations is often critical to optimal design of remediation systems. Conventional soil coring of unconsolidated sediments leads to drainage and redistribution of fluids during sample withdrawal and storage. Moreover, extraction and conventional analytical testing of contaminated soils (e.g., solid-liquid extraction followed by gas chromatography) is inadequate because of redistribution and volatilization of contaminants during processing. Here, we present a novel approach of using nuclear magnetic resonance (NMR) for scanning of frozen soil cores, using trichloroethene (TCE) as the model contaminant. Cryogenic coring has the potential to prevent fluid displacement. NMR can provide information on the qualitative and quantitative spatial distribution of non-aqueous phase liquid (NAPL) contaminants. Initial results indicate that strong NMR signals of water-bound hydrogen overwhelm the NMR signals of TCE-bound hydrogen at ambient temperature ( $\sim 20^{\circ}\text{C}$ ). However, when the soil is frozen at  $-20^{\circ}\text{C}$ , TCE remains in liquid phase (melting point of TCE is  $-73^{\circ}\text{C}$ ) and thus detectable by NMR, while the water is now frozen, leading to signal suppression of the water-bound hydrogen. Furthermore, comparison of known and measured TCE concentrations shows close agreement (approximately 90%). The results confirm the ability of NMR method to discriminate between water and TCE in frozen cores, thus allowing for a sensitive spatial analysis of contaminant distribution. Overall, this novel approach has the potential to enable high-throughput soil core analysis, lowering the cost of site investigation while providing an improved basis for remediation planning.