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Removal of non aqueous phase liquid liquid (NAPL) from a loam soil monitored by time domain reflectometry (TDR) technique

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Non-aqueous phase liquids (NAPLs) are compounds with low or no solubility with water. These compounds, due to the several human activities, can be accidentally introduced in the soil system and thus constitute a serious geo-environmental problem, given the toxicity level and the high mobility. The remediation of contaminated soil sites requires knowledge of the contaminant distribution in the soil profile and groundwater. Methods commonly used to characterize contaminated sites are coring, soil sampling and the installation of monitoring wells for the collection of groundwater samples. The main objective of the present research is to explore the potential application of time domain reflectometry (TDR) technique in order to evaluate the effect of contaminant removal in a loam soil, initially contaminated with NAPL and then flushed with different washing solutions. The experimental setup consist of: i) a Techtronix cable tester; ii) a three-wire TDR probe with wave guides 14.5 cm long inserted vertically into the soil samples; iii) a testing cell of 8 cm in diameter and 15 cm high; iv) a peristaltic pump for upward injection of washing solution. In laboratory, soil samples were oven dried at 105°C and passed through a 2 mm sieve. Known quantities of soil and NAPL (corn oil, a non-volatile and non-toxic organic compound) were mixed in order to obtain soil samples with different degrees of contamination. Once a soil sample was prepared, it was repacked into a plastic cylinder and then placed into the testing cell. An upward injection of washing solution was supplied to the contaminated sample with a rate q=1.5 cm3/min, which corresponds to a darcian velocity v=6.0 cm/h. The out coming fluid, from the soil column was collected, then the washing solution and oil was separated. Finally both the amount of oil that was remediated and the dielectric permittivity (measured via TDR) of the contaminated soil sample were recorded. Data collected were employed to implement a multiphase mixing model which permitted conversion from a dielectric permittivity domain into a NAPL domain. The results of this study show that, in most cases the TDR device is NAPL-sensitive. Further works will be built on this initial study, concentrating on improving the dielectric response-database, in order to validating the developed procedure at a field scale.