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Lysimetric experiments to characterize the multiphase mobilization of LNAPL in contaminated soils by a multi-method monitoring approach under controlled climatic scenarios.

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Light-non-aqueous phase liquids (LNAPLs) are important sources of soil contamination worldwide. Significant fluctuations of the soil bio/geochemical properties (metabolisms types, redox) and significant spatial-temporal variations of the pollutant saturation distribution occur on the LNAPL different phases (pure phase, dissolved, residual, entrapped droplets). These fluctuations are often strengthened by the multiple imbibition/drainage cycles caused by groundwater level variations that affect the three-phase fluids distribution in the soil (LNAPL, gas, and water) and the LNAPL release rates towards the dissolved and the gaseous phase [1,2]. Hence, the real LNAPL soil saturation distribution cannot be easily inferred from the thickness of LNAPL in monitoring wells, complicating the contamination characterization and the remediation actions, often long and costly. For these reasons, monitoring methods need to be improved to better characterize the contamination in integrating both the multi-compound and the multi-phase aspects. The relation between the LNAPL mobilization mechanisms and the groundwater level dynamic need also to be further understood, especially in the climate change context where increased groundwater fluctuations are expected [3]. For this purpose, we instrumented two lysimetric soil columns (2 m³) contaminated with LNAPL. The device combines in-situ monitoring (electrical permittivity and conductivity, soil moisture, temperature, pH, RedOx) and direct sampling and measurements in monitoring wells, gas collection chambers, and suction probes. This equipment allows the assessment of the multi-component and multi-phase LNAPL release (pure, dissolved, and gaseous phases) and soil saturation distributions (electrical permittivity and conductivity) under controlled scenarios of precipitation and groundwater fluctuation patterns. The dissolved, gaseous, and pure LNAPL phases were characterized in the lab by GC-MS and field μ GC technics. Meanwhile, 1D column experiments allowed the determination of the soil hydrological properties during LNAPL/water/air imbibition/drainage cycles. Our first scenarios (120 days of monitoring), shows that the coupling of physical-chemical, geophysical, and hydrological monitoring methods allows a global characterization of the contamination and its behavior during groundwater table variation scenarios. This experiment also demonstrated that increasing the groundwater level variation intensity accentuates the spreading and trapping of the pure LNAPL phase across the soil porosity, which favors LNAPL volatilization and dissolution processes. These findings will allow to better identify and combine key LNAPL processes to improve models and strengthen the recommendations concerning the characterization and monitoring programs for hydrocarbons polluted sites.

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Participation

In-Person

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