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HOW DO THE GROUNDWATER LEVEL FLUCTUATIONS MAY AFFECT THE REMOBILIZATION OF LNAPLs?

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Accidental releases of petroleum products, such as light non-aqueous phase liquids (LNAPLs), are one of the most common sources of groundwater and soil pollution worldwide (Rivett et al., 2014). Yet, despite numerous studies, the behavior of these contaminants is not fully understood. The remediation of LNAPL contaminated sites, complex, long, and expensive remains, therefore, not always successful. During the LNAPLs' infiltration through the unsaturated zone, part of them remains trapped in pores by capillary and viscous forces. The most volatile compounds are directly transferred into the atmosphere, creating harmful emissions of volatile organic carbon. The others accumulate at the top of the groundwater forming a continuous floating 'free' phase at the origin of a long-term dissolved LNAPL groundwater plume. Derived from petroleum-based fuels, these hydrocarbon contaminants often consist of a toxic and complex mixture of several components (BTEX, aliphatic and polyaromatic hydrocarbons...) with various chemical properties (solubility, sorption capacity, volatility...) that can make groundwater resources unsuitable for both drinking water supply and agriculture for several decades. During pump-induced or seasonal groundwater level fluctuations, this floating free LNAPL phase can be vertically spread at the capillary fringe, favoring their release into the environment (Gupta et al., 2019). However, the effect of these fluctuations on LNAPL remobilization processes remains unclear and difficult to predict. Yet, the Intergovernmental Panel on Climate Change (IPCC) predicts significant changes in precipitation and groundwater recharge patterns (IPCC, 2014) that can greatly intensify the groundwater level fluctuations by 2100. This context may significantly affect the LNAPL mobilization processes and their release to the air and groundwater. It is, therefore, urgent to further understand the effect of these water-table fluctuations on LNAPLs mobilization processes at contaminated sites.

To this purpose, a new original experimental system combining *in situ* physical-chemical (pH, Eh, temperature), geochemical, and indirect geophysical (electrical conductivity, permittivity) measurements was developed at the GISFI (Scientist Group on brownfield sites: <http://gisfi.univ-lorraine.fr>) station, Homécourt, France. The main part of this instrumentation (lysimeter columns) is presented in Figure 1. This experimentation aims to assess and compare the nature and the amount of LNAPLs release into the atmosphere and groundwater from contaminated soils during two groundwater level fluctuations and precipitation scenarios. One scenario corresponds to the 'current' precipitation pattern based on regional climate records (on the right, Figure 1). The other (on the left, Figure 1) is based on the predictions of the most extreme IPCC scenario (IPCC, 2014) and consists of a greater groundwater table fluctuation zone and less frequent but more extreme precipitation events. This study will be conducted from laboratory decametric columns to 2 m³ lysimeters scales and on soils of different geological complexity (homogeneous sandy soil and natural alluvial soil). The remobilized hydrocarbons will be collected via gas collection chambers (gaseous emissions) and suction

cups (dissolved LNAPL phase) as the groundwater table fluctuates (Figure 1) and will be regularly analyzed (GC-MS, FTIR).

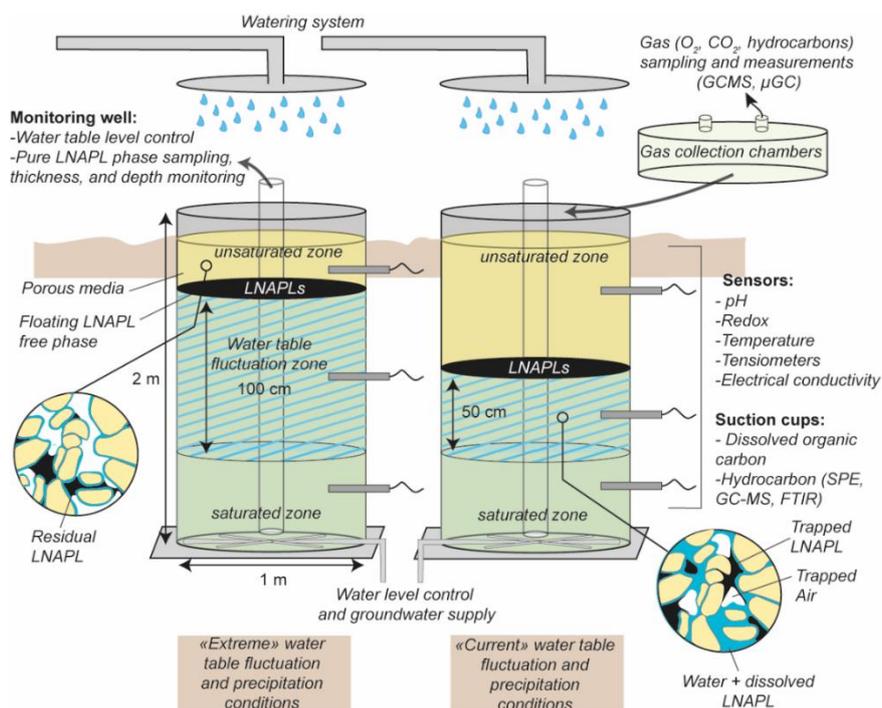


Figure 1. Instrumentation of the lysimeter columns for the two climatic scenarios: current and extreme (climate change) conditions. The circular images show the expected distribution of the LNAPL phase in the porosity.

Attention will be paid to the evolution of the concentration and composition of the dissolved LNAPL phase over time. Monitoring wells will also allow the sampling, measurement, and monitoring of the pure LNAPL phase thickness and chemical composition variation (Figure 1). Numerical simulations of the LNAPL flow and transport through the contaminated soil will also be carried out to identify the processes responsible for the pollutant remobilization. The complementarity of these monitoring methods should provide (1) a further understanding of the fate of these hydrocarbons at contaminated sites; (2) a better assessment of the environmental risks associated with these contaminated sites and their evolution under the expected climate change effect.

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