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Spatial resolution of groundwater volatile organic compound pollution using passive samplers

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A large part (near 40 %) of the Lille Metropolis water resources (> 1million inhabitants) is impacted by the presence of chlorinated aliphatic hydrocarbons such as perchloroethene (PCE), 1,1,1-trichloroethane (TCA) and trichloroethene (TCE) which are among the most commonly found chemicals polluting groundwaters worldwide. The characterization of these groundwaters have been undergone deploying passive samplers to better characterize the high spatial variability, as these compounds are often present as dense nonaqueous phase liquids (DNAPLs).
The determination of equilibration time of polyethylene diffusion bags (PDBs) was performed for 9 VOCs. The equilibrium between the surrounding water and the sampler is reached (> 97 % in average) after 4 days for trans TCE; 1,1-dichloroethylene (DCE); trans-1,2-DCE and vinyle chloride. At this time of the experiment, only 90 % of the equilibrium is reached for PCE and cis-1,2-DCE; 78 % for 1,1,1-trichloroethane and 67 % for 1,1- and 1,2-dichloroethane.
The PDBs deployed in 19 piezometers at 3 different depths in three different seasons showed a clear correlation between the PDBs concentration assessments and the analysis of waters sampled by pumping at the same depth for the 4 compounds (PCE, TCE, 1,1,1-TCA and 1,1-dichloroethane) showing high concentration distributions. The classical method of groundwater sampling based on pumping until the theoretical renewal of the water column is shown here to not provide a water sample representative of the whole water column, but only of the first depth and then of the water arriving horizontally.
The deployment of PDBs at different depths and additional logs (dissolved oxygen and conductivity) showed the presence of large gradients of VOCs (e.g. the concentration of cis-1,2-DCE increasing from < 0.2 up to 125 μg L-1 within few meters), usually correlated with the modification of waters origins underlined by the modification of conductivity.