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Modelling the depletion of a coal tar creosote DNAPL source zone

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At a former creosote-processing plant a coal tar oil impact resulted in a DNAPL contamination of an aquifer up to 50 m depth. Monitored Natural Attenuation (MNA) has been chosen to be evaluated as an alternative remediation strategy. The evidence for biodegradation in the contaminant plume was demonstrated using signature metabolite analysis (SMA), compound-specific isotope analysis (CSIA) and redox-sensitive tapes. Nevertheless, most of the DNAPL mass is located in the source zone. Hence, a detailed source zone investigation was performed using cone penetration testing (CPT) in combination with laser-induced fluorescence (LIF) sensor to delineate the DNAPL distribution within the source zone. Based on the CPT and LIF data optimal soil samples were taken to provide information on the distribution of the DNAPL saturation throughout the source zone. The groundwater flow was simulated using MODFLOW. The hydrogeochemical modelling was carried out with the multi-component reactive transport code MIN3P. The results of the modelling shows that the maximum mass flux of naphthalene from the source zone occurs around 50 years after the contaminants entered the saturated zone. The complete depletion of the entire mass of naphthalene in the source zone requires around 1,000 years. The results of the 2D and 3D simulations can be compared with each other indicating that the 2D model might be sufficient to forecast the source zone depletion. As a prerequisite the maximum extension of the source zone parallel to the groundwater flow direction must be identified. Nevertheless, the depletion time can range between hundred and several ten thousand years and is strongly depending on the considered compound. Therefore, treating creosote as a contaminant group by using averaged parameters in transport modelling can lead to a significant wrong prognosis for the depletion time of a source zone.