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SIMULATION OF MOBILE COMPONENT MIGRATION RISK FROM A CRUDE OIL ACCIDENTAL SPILL THROUGH THE VADOSE ZONE

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Abstract

Preventing and reducing the risk of soil and aquifer pollution by predicting pollutant concentrations that could impact the geological environment in the event of accidental oil spills enables the implementation of optimal technical measures to prevent and mitigate their effects. This study investigates the migration of crude oil pollutants at a contaminated site to estimate the long-term impact of topsoil contamination of groundwater. The research is based on data from the literature, laboratory analyses of different types of oil, and simulations using the UnSat Suite Plus – SESOIL Module to model the migration of petroleum hydrocarbons through the vadose zone into the aquifer. Given the limitations of the SESOIL module in assessing oil compound migration risks, the study relies primarily on literature data, and the results are evaluated against environmental legislation targets.
In a hypothetical scenario involving the spill of a very light crude oil on the ground surface, with total petroleum hydrocarbon (TPH) concentrations in soil reaching up to 1% (maximum 10,000 mg/kg), simulations of the migration of the most mobile oil compounds as BTEX (Benzene, Ethylbenzene, Toluene, and Xylenes) through the unsaturated zone to the aquifer indicate that maximum pollutant concentrations at the aquifer upper boundary remain below the legal limits. In this case, the actual risk of groundwater contamination via BTEX infiltration through the vadose zone is low. Most crude oil compounds, particularly TPH-type hydrocarbons, are insufficiently mobile to penetrate the vadose zone and tend to remain in the surface soil layer in the absence of direct migration pathways.

Key words: BTEX (Benzene, Ethylbenzene, Toluene, Xylenes), CoPC (constituents of potential concern), TPH (Total Petroleum Hydrocarbons), NAPL (nonaqueous liquid phase), vadose zone

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