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A comprehensive model for the dehalogenation of chlorinated solvents

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Chlorinated solvents and other dense nonaqeous phase liquids (DNAPLs) are widespread, hazardous contaminants in groundwater. Bioremediation within DNAPL source zones is a promising approach for degrading these contaminants to harmless species. A review of biodegradation research on immiscible phase tetrachlorethylene (PCE) and trichloroethylene (TCE) revealed that current modelling has not yet properly accounted for the complexity of processes observed in laboratory studies. A comprehensive numerical model for simulating the dehalogenation of PCE and TCE by the cultures containing strain 195 was developed. It considers the kinetic dissolution of DNAPL, bacterial growth and decay, and the interaction of biological and geochemical reactions that might influence biological activity, particularly in the proximity of high DNAPL saturations. In addition to the standard biodegradation pathways, fermentation processes are incorporated which may provide competition for electron donors with the dehalogenating bacteria. Simulations conducted with the model provide insight into the dominant processes occurring within microcosm experiments of PCE biodegradation. This process-based numerical model will support lab and field work for the first in-situ, field DNAPL source area bioremediation trial in Europe: the UK-based LINK RTDF-UK SABRE Project.