

## Simulating transient redox zonation and its impact on the fate of micropollutants during managed aquifer recharge

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Managed aquifer recharge (MAR) is increasingly used to enhance the sustainable development of water supplies. Common recharge techniques include aquifer storage and recovery (ASR), infiltration ponds, river bank filtration and deep-well injection. In those systems the degradability of many organic micropollutants and trace metals within the subsurface is closely linked to the redox conditions that prevail within the groundwater system. As a result, spatial and temporal redox gradients might lead to highly variable attenuation rates for these pollutants. A comprehensive understanding of redox processes and delineation of redox zones can therefore become an important prerequisite to assess and predict the fate of these substances. Here we describe the results from two case studies: a deep-well injection experiment in the Netherlands [1] and a pond infiltration scheme in Berlin, Germany [2], where reactive transport modelling has shown to be a powerful tool to systematically analyse field data from MAR sites.

For both field studies it was demonstrated that the observed transient changes in redox zonation is linked to seasonal temperature variations of the recharge water. At the deep-well injection site pyrite oxidation was identified as the major reductant, controlling the extent of the aerobic and denitrifying zones around the injection well. At the pond infiltration site, the extent of the aerobic zone and the corresponding fast removal of phenazone were controlled by temperature-dependent organic matter mineralization.

[1] Prommer & Stuyfzand (2005) *ES&T* **39**, 2200-2209.

[2] Greskowiak *et al.* (2006) *ES&T* **40**, 6615-6621.

## The abiotic production of hydrocarbons at the Lost City Hydrothermal Field

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The Lost City Hydrothermal Field is an off-axis, moderate temperature, ultramafic-hosted hydrothermal site. Because Lost City fluids are not overprinted by the chemistry of high-temperature mid-ocean ridge processes, unique insights into the origin of the high hydrocarbon concentrations can be made. Stable and radiocarbon isotope data from hydrocarbons dissolved in the hydrogen-rich fluids indicate an abiogenic source. A distinct “inverse” trend in the stable carbon *and* hydrogen isotopic composition of C<sub>1</sub>-C<sub>4</sub> hydrocarbons is compatible with Fischer-Tropsch Type (FTT) production. Radiocarbon dead methane precludes seawater bicarbonate as the carbon source for FTT reactions. Helium concentrations similar to those from mid-ocean ridge hydrothermal fluids, but with anomalously low CO<sub>2</sub>/<sup>3</sup>He ratios, suggest that the carbon source to FTT reactions is mantle-derived, likely leached from the host rocks. The mantle-rock CO<sub>2</sub> is converted to hydrocarbons, yielding fluids with μmolar concentrations of CO<sub>2</sub> and 1-2 mmolar concentrations of ΣC<sub>1</sub>-C<sub>4</sub> alkanes+alkenes. Given estimates of conversion efficiency and mantle rock CO<sub>2</sub> content, relatively low (less than approximately 5) water to rock ratios (W/R) are required to satisfy this model.