Microbial activity, mass transfer, and geochemical processes during degradation of chlorinated ethenes: experiments and model-based interpretation

ALEXANDRA MURRAY[1], JULIEN MAILLARD[2], BIAO JIN[3], METTE M. BROHOLM[1], CHRSITOF HOLLIGER[2], MASSIMO ROLLE[1]

[1]Department of Environmental Engineering, Technical University of Denmark, 2800 Lyngby, Denmark (almu@env.dtu.dk; masro@env.dtu.dk)

[2]Laboratory for Environmental Biotechnology, ENAC-IIE, Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland

[3]State Key Laboratory of Organic Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Science, China

Chlorinated ethenes are the most widespread source of organic contamination in groundwater and are also frequently detected in hyporheic zones and surface water bodies [1]. Biodegradation of these compounds in aquatic environments depends not only on the activity and metabolic capabilities of specific microorganisms but also on microbial community interactions [2], mass transfer, and geochemical processes.

We present microbial assays of chlorinated ethene degradation performed in three-phase batch setups in which a consortium of organohalide-respiring bacteria (OHRB) was cultivated alone or in presence of iron- and/or sulfate-reducers. Sulfate respiration was found to have an important effect on the degradation rates of tetrachloroethene (PCE) and the daughter products dichloroethene (*cis*-1,2-DCE) and vinyl chloride (VC). The effect of iron respiration on degradation of the chlorinated compounds was found to be negligible when the microbial community comprised only OHRB and iron reducing bacteria.

To quantitatively interpret the experimental observations (i.e., hydrochemical and T-RFLP data) we developed a modelling approach based on a MATLAB®-PHREEQC coupling. The model allowed us to determine the kinetics of the different bacterial guilds and to describe multi-phase mass transfer between the gaseous, organic and aqueous phases in the batch setups, as well as the dynamics of the microbial populations and the geochemical reactions that occurred in the aqueous phase.

[1] Weatherill et al. (2018) *Water Res.* **128**, 362-382. Buttet et al. (2018) *FEMS Microbiol. Ecol.* **94**, 1-11.