Organohalide-respiring bacteria community competition dynamics: Experiments and model-based interpretations

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Organohalide respiration (OHR) and the sequential degradation of chlorinated ethenes are well understood processes, yet despite this, natural attenuation and bioremediation efforts sometimes stall before the non-toxic endpoint, ethene, is reached. To investigate if influence from the subsurface microbial community cause or contribute to this, laboratory experiments were conducted and a novel microbial community model was developed.

Two OHR bacterial consortia were used, one that degrades perchloroethene (PCE) to trichloroethene and another that degrades *cis*-1,2-dichloroethene (cDCE) to ethene. To determine the effect of competition for electron donor, in this case hydrogen, on OHR, the consortia were combined with varying amounts of an iron-respiring bacterium and a sulfate-respiring bacterium. The communities were cultivated in anaerobic bottles containing aqueous medium, a layer of hexadecane containing the PCE or cDCE source, and a headspace filled with a 4:1 mixture of hydrogen and carbon dioxide.

Preliminary results show that sulfate reduction negatively affects PCE dechlorination and may positively impact cDCE reduction. To quantitatively evaluate the experimental results we performed reactive transport modeling of the multiphase setup. The model accounts for the mass transfer of the chlorinated ethenes and hydrogen in the three-phase system (Aeppli et al., ES&T, 2009), for the effect of mass removal during repetitive sampling (Buchner et al., ES&T, 2017), and allows simulating contaminant degradation coupled to the dynamics of the three bacterial guilds. The model can also describe geochemical reactions associated with microbial activity in the aqueous phase through direct coupling with the geochemical simulator PHREEQC (Parkhurst and Appelo, USGS, 2013).