Biotic and Abiotic Degradation of 1,1,2-Trichloro-1,2,2-Trifluoroethane (CFC-113): Implications for Detoxification of Chlorinated Ethenes

Jeongdae Im (jeongdaei@ksu.edu) (Kansas State University, Manhattan, KS, USA)
E. Erin Mack (DuPont Corporate Remediation Group, Newark, DE, USA)
Edward S. Seger (The Chemours Company, Wilmington, DE, USA)
Frank E. Löffler (University of Tennessee, Knoxville, TN, USA, Oak Ridge National Laboratory, Oak Ridge, TN, USA)

Background/Objectives. Chlorofluorocarbons such as 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113) were widely used as cleaning agents, often in combination with chlorinated solvents such as trichloroethene (TCE). As a result, CFC-113 occurs as (co-) contaminant at many sites. We examined the inhibitory effect of CFC-113 on microbial TCE reductive dichlorination, and further investigated potential attenuation mechanisms for CFC-113.

Approach/Activities. To assess the impact of CFC-113 on TCE reductive dechlorination rates, batch culture experiments with the organohalide-respiring consortium SDC-9™ containing TCE, lactate, and varying concentrations of CFC-113 were conducted. We further explored potential attenuation processes for CFC-113 including (i) microbial degradation under oxic and anoxic conditions, (ii) abiotic degradation mediated by reactive minerals, and (iii) corrinoid-catalyzed biomimetic transformation.

Results/Lessons Learned. CFC-113 significantly inhibited TCE reductive dechlorination in a concentration-dependent manner. Reductive dechlorination of TCE by the SDC-9™ consortium stalled at *cis*-1,2-dichloroethene in the presence of 7.6 mM CFC-113, and a similar inhibitory effect was observed on 1,2-dichloropropane reductive dechlorination by *Dehalogenimonas lykanthroporepellens* strain BL-DC-9. River sediment microcosms demonstrated that CFC-113 was subject to microbial degradation under anoxic conditions, but the degradation activity was not sustained in transfer cultures. No degradation was observed in incubations with reactive minerals including mackinawite, green rust, magnetite and manganese dioxide. Reduced cyanocob(I)alamin mediated *in vitro* reductive dechlorination and defluorination of CFC-113 to difluoroethene as end product. Further defluorination was not observed. This biomimetic degradation of CFC-113 was demonstrated *in vivo* using the corrinoid-producing acetogen *Sporomusa ovata*. Taken together, these findings suggest that CFC-113 can compromise in situ bioremediation of chlorinated ethenes; however, co-metabolic reductive degradation of CFC-113 can be achieved by microorganisms that produce cob(I)amides.