Probing the mechanism of anaerobic trichloroethene biodegradation with dual element carbon and chlorine isotope analysis

L. M. DOUGLAS[1]*, S. CRETNIK[2], A. PÉREZ-DE-MORA[2], M. HÖCHE[2], A. H. MEYER[2], O. SHOUAKAR-STASH[3], E. A. EDWARDS[4], B. SHERWOOD LOLLAR[1] AND M. ELSNER[2]

[1]Department of Earth Sciences, University of Toronto, Toronto, Ontario, Canada M5S 3B1 (*correspondence: douglas@es.utoronto.ca)
[2]Institute of Groundwater Ecology, Helmholtz Zentrum München, 85764 Neuherberg, Germany
[3]Department of Earth Sciences, University of Waterloo,Waterloo, Ontario, Canada N2L 3G1
[4]Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Ontario, Canada M5S 3E5

Compound specific isotope analysis can be used to quantify the *in situ* biodegradation of toxic chlorinated ethenes, such as trichloroethene (TCE), in groundwater. However, while the anaerobic biodegradation of TCE occurs via reductive dechlorination, the magnitude of observed kinetic isotope effects for carbon has varied widely for different bacteria and enrichment cultures [1]. This variability could indicate different initial transition states within the reaction mechanism or masking of the observed carbon kinetic isotope effect due to additional rate-limiting steps (e.g. substrate binding, mass transfer limitations) during the degradation of TCE.

Here, we probe the details of the reductive dechlorination mechanism for different reductive dehalogenases in mixed enrichment cultures using dual element ($\Delta\delta^{13}C/\Delta\delta^{37}Cl$) isotope analysis. The slopes of dual element isotope plots remain largely constant even when masking suppresses observable kinetic isotope effects, so different slopes indicate a different initial transition state in the degradation mechanism [2]. Carbon and chlorine stable isotope ratios were observed during TCE biodegradation by a number of mixed enrichment cultures grown in microcosms with different chlorinated substrates to select for particular TCE-degrading reductive dehalogenases. This two-dimensional approach has the potential to elucidate whether different reductive dehalogenases use the same transition state in the rate-limiting step of TCE biodegradation.

[1] Cichocka *et al* (2008) *Chemosphere* **71**, 639 [2] Elsner (2010) *J. Environ. Monit.* **12**, 2005