Linking geochemical tracers with metabolic pathways and back: A case study with dissimilatory sulfate reduction

B. WING[1]*, L. LAU[2] AND B. WEBBER[2]

[1]Department of Earth and Planetary Sciences and GEOTOP, McGill University, Montréal, Canada H3A 2A7 (*correspondence: boswell.wing@mcgill.ca)
[2]Faculty of Science Freshman Program, McGill University, Montréal, Canada H3A 2A7 (lawrence.lau2@mail.mcgill.ca, benjamin.webber@mail.mcgill.ca)

From inferences about some of Earth's earliest microbial occupants [1] to tracing the progressive oxidation of Earth surface environments [2] to estimating rates of microbial metabolisms in largely inaccesible environments [3], the isotopic consequences of dissimilatory sulfate reduction (DSR) can constrain biogeochemical processes across a range of temporal and spatial scales. as such, the relationship between isotopic fractionation and the DSR metabolic pathway stands as a canonical example of the power of linking geochemial tracers to specific metabolisms. As a result, much work has focused on quantitative reconstruction of the net isotopic effect associated with the DSR pathway, starting with pioneering efforts in the early 1970s [4]. Recent efforts have expanded this approach by examining the total isotopic signatures of DSR (e.g., multiple S isotopes [5]), which has resulted in phenomenologically crisp descriptions of isotopic fractionation occuring in culture experiments [6].

Despite this empirical validation, the isotopic effects associated with DSR remain somewhat mechanistically obscure. In large part this is because previous models have focused on the DSR metabolic pathway alone. We will present ongoing work that couples recent developments in isotope modelling of the DSR pathway to a genomically-constrained flux-balanced model of core metabolism of the sulfate-reducing microbe *Desulfovibrio vulgaris* [7]. Our presentation will explore the range of net sulfur isotope effects produced by biologically-relevant variations in the control parameters for the entire *D. vulgaris* metabolism, as well as highlight the pitfalls and promise of such an approach.

[1] Shen *et al.* (2001) *Nature* **410**, 77-81. [2] Halverson & Hurtgen (2007) *EPSL* **263**, 32-44. [3] Rouxel *et al.* (2008) *EPSL* **268**, 110-123. [4] Rees (1973) *GCA* **37**, 1141-1162. [5] Farquhar *et al.* (2007) *GCA* **71**, 5862-5875. [6] Johnston *et al.* (2007) *GCA* **71**, 3929-3947. [7] Stolyar *et al.* (2007) *Mol. Sys. Biol.* **3**, 92.

Charcoals for land remediation

J. WINGATE[1], H. SNEATH[2], F. DE LEIJ[2] AND T. HUTCHINGS[1]

[1]Forest Research, Alice Holt Lodge, Farnham, Surrey, GU10 4LU (Jeremy.wingate@forestry.gsi.gov.uk)
[2]School of Biomedical and Molecular Sciences, University of Surrey, Guildford, Surrey, GU2 7XH (F.de-leij@surrey.ac.uk)

Charcoal is widely used in water and air filters, where its adsorbent properties ensure effective removal of toxins. Surprisingly, the use of charcoal for the remediation of contaminated soil is still in its infancy. Given that charcoal is inert, permanent adsorption of pollutants onto charcoal could provide effective, long-term remediation solutions. Using specific source materials, we were able to create non activated charcoals that can adsorb > 3 mol of heavy metals per kg charcoal (3 times more than the adsorption capacity of bone charcoal). Applications of specific charcoal material fully restored plant growth and eliminated metal leaching, when added at a rate of 1% (w/w) to mine spoil with highly elevated metal concentrations.

Metal adsorbing charcoals can be used to remove metal toxicity from soil and thus restore the activity of micro-organisms that metabolise organic pollutants. In cases where indigenous populations of hydrocarbon degrading organisms are scarce, we have developed charcoals that can carry as many as 10^{10} hydrocarbon degraders per g charcoal allowing rapid establishment and colonisation with hydrocarbon degraders within highly polluted environments. For diesel spills, we have demonstrated increases in degradation by more than 10 fold using this approach.

The combined effect of adsorption of pollutants onto charcoal and stimulation of microbial activity makes charcoal applications ideal for land remediation especially where soils are cross contaminated with metals and organics.