The role of exopolymers in the speciation of redox-sensitive metals: Implications for metal cycling in biofilms

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We are studying the kinetics of Cr(VI) and Fe(III) reduction using EPS and non-EPS producing mutants of *Pseudomonas putida* in order to quantify the role of biofilms in the cycling and speciation of redox-sensitive metals. Our justification is that in some natural environments (e.g. subsurface), respiration is limited by lack of labile organic matter, requiring indigenous bacteria to find alternatives sources. Since bacteria form biofilms in nature, we hypothesized that EPS represents a labile pool of dissolved organic matter[1], because > 90% of the biomass in biofilms is in the form of EPS[2].

Our study involves two complimentary approaches. We conduct metal reduction experiments using planktonic cells, with metal speciation analysis using traditional wet chemical methods (diphenylcarbazide for hexavalent chromium and ferrozine for ferrous iron). Additionally, we perform metal reduction experiments using biofilms grown on glass slides, and determine metal speciation by XPS.

Preliminary results using Cr(VI) in planktonic cultures show that the reduction rate follows first order kinetics with respect to Cr(VI) concentration, consistent with previous studies. Moreover, a higher reduction rate is observed in the presence of EPS, and this appears to scale with the dissolved organic carbon in the suspensions. These findings imply an important role for EPS in maintaining viable microbial populations through recycling of both metals and organic matter.

[1] Tourney *et al.* (2008) *Chem. Geol.* **247**, 1-15. [2] Liu *et al.* (2007) *J. Photochem. Photobiol.* A, Chem. **190**, 94-100.

Low mature coal-dervied gases from the Turpan-Hami Basin, Northwest China

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Natural gas can be formed from microbial activities on sedimentary organic matter (biogenic gas, nearly exclusively composed of CH_4) and from the thermal breakdown of organic matter (thermogenic gas, composed of CH_4 and higher homologues). According to the source rock type, thermogenic gas can be further subdivided into coal-derived gas (terrestrial) and oil-type gas (marine). Since natural gases are dominated by some simple and low-molecular hydrocarbons, stable carbon isotopic values have great importance on genetic information. Here we show some low mature coal-derived gas with significantly low carbon isotopic values of methane from the Turpan-Hami Basin, Northwest China.

The Turpan-Hami Basin is located in the eastern Xinjiang, Northwest China and has an area of 53500 km^2. The main reservoir rocks for natural gases in the basin are Jurassic coal measures and the source rocks are dominated by middle-late Jurassic coal measures. Hydrocarbon gases account for more than 97% of the natural gases from Turpan-Hami Basin, and the content of non-hydrocarbon gases (N_2, CO_2, etc.) is quite low, averagely less than 2%. C_1/C_{1-5} ratios are normally less than 0.9. Carbon isotopes demonstrate an orderly isotopic trend ($\delta^{13}C_1>\delta^{13}C_2>\delta^{13}C_3>\delta^{13}C_4$). For C_1, C_2, C_3 and C_4, the carbon isotopic ratios are averaged at -42.2‰, -26.7‰, -25.6‰ and -24.8‰, respectively.

Compared to oil-type gases, coal-derived gases are isotopically heavier (-22‰~-38‰ for $\delta^{13}C_1$) and drier (more methane-rich) (Patience, 2003). The relatively low $\delta^{13}C$ values and content of methane in the Turpan-Hami Basin is due to the fact the these natural gases are normally from the coal-derived oil and gas fields in the Taibei depression where the middle-late Jurrasic coal measures have very low maturity level (Ro of 0.5%-0.9%). Mixing from biogenic gases can be excluded since no evidence of the presence of biogenic gases in this basin has ever been reported. It is concluded that coal-derived gases can be formed under conditions of very low temperature and low level of maturity.

[1] Patience, R.L. (2003) Where did all the coal gas go? *Org. Geochem.* **34**, 375-387.