The electrochemical variability of cyanobacterial surfaces

STEFAN LALONDE, KURT KONHAUSER AND GEORGE OWTTRIM

Departement of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E3 (stefanw@ualberta.ca)

Bacterial surfaces act as efficient metal scavangers with important roles in a variety of geochemical processes. As a result, surface complexation models have been used in an to attempt to develop quantitative and predictive tools with broad relevancy. Such models have aimed to quantify the extent of metal and proton adsorption to bacteria by relying on established thermodynamic and mass balance data used in combination with experimentally-derived surface site functional group concentrations and deprotonation constants. Daugney et al. (2001) were the first to consider potential biological sources of error in such experimentally derived data by showing that different growth phases of *Bacillus subtilis* led to variations in ligand concentrations and metal sorption.

In order to identify potentially important biological variations more relevant to natural systems, we grew the heterocyst forming, filamentous and nonsheathed cyanobacteria *Anabaena sp.* PCC7120 on various nitrogen sources, and then performed acid-base titrations and electrophoretic mobility measurements on the cell surface during different growth phases. We found that surface site concentrations, as well as deprotonation constants, varied in conserved trends with both growth phase and nitrogen metabolism. Electrophoretic mobility data supports a cell surface that is highly sensitive to growth conditions and nutritional mode.

These results open new avenues of consideration with regards to the geochemical modelling of bacteria-metal interaction.

Fe(II) adsorption at the cell-water interface: From macroscopic observations to spectroscopic measurements

P. LARESE-CASANOVA[1], M.R. LEONARDO[2] AND M.M. SCHERER[1]

[1]Civil and Environmental Engineering, The University of Iowa, Iowa City, IA, USA (michelle-scherer@uiowa.edu)
[2]Microbiology & Molecular Biology, Coe College, Cedar Rapids, IA, USA (mleonard@coe.edu)

Aqueous Fe(II) formed from bacterial respiration of Fe(III) oxides may form a precipitate on or adsorb to oxides or cells. On cell surfaces Fe(II) is suspected to bind with carboxyl and phosphoryl groups, but the identity of surface-bound Fe(II) species is not yet clear. Moreover, the accumulation of Fe(II) on *Shewanella* cells can be described with a Langmuir isotherm [1] and may even inhibit Fe(III) oxide reduction activity [2]. However, the distinction between Fe(II) surface adsorption and precipitation has not been evaluated.

We are using ^{57}Fe Mössbauer spectroscopy to study the binding nature of Fe(II) interacting with bacteria cells. The Mössbauer technique is a similar approach used to study Fe(II) adsorbed at mineral surfaces [3]. We are examining whether Fe(II) interaction is similar among various iron reducing bacteria and how surface Fe(II) species change over the environmentally-relevant range of pH and Fe(II) concentrations.

Preliminary results suggest that that sorption of ^{57}Fe(II) on *Shewanella putrefaciens* CN32 (10^{10} cells mL^{-1}, pH 7.4) results in two distinct Fe(II) species as revealed in 140K Mössbauer spectrum. No signal was observed on frozen cells alone. The Fe(II) species are represented as doublets with center shifts and quadrupole splittings (CS, QS) of (1.32, 3.21 mm s^{-1}) and (1.29, 2.58 mm s^{-1}). Neither signal appears consistent with solid ferrous hydroxide, but the (1.29, 2.58 mm s^{-1}) doublet is similar to Fe(II) sorbed on Al_2O_3 and TiO_2 at 4.2K [3]. Additional experiments are underway to evaluate whether the two Fe(II) species represent forms of sorbed Fe(II).

References

[1] Liu, C., et al. (2001). *Environ. Sci. & Technol.* 35(7), 1385-1393.
[2] Roden, E.E., Urrutia, M.M.(2002). *Geomicrobiology Journal*. 19, 209-251.
[3] Williams, A.G.B., Scherer, M.M. (2004). *Environ. Sci. & Technol*. 38(18), 4782-4790.