Mineral surface charge development in mixed electrolytes

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Electrolyte ions play a central role in electric double layer formation at mineral/water interfaces. The presence of these ions in aqueous solutions is in fact essential for neutralizing charges of potential-determining ions (H^+, OH^-) coordinated to mineral surfaces. The charge-neutralizing capacity of electrolyte ions is notably controlled by their size-to-charge ratio as well as their ability at forming or breaking water structures. Although much has been learned through the study of Hofmeister-type series of ions, understanding effects of co-existing ions at mineral/water interfaces is central to the elucidation of multicomponent systems representative of geochemical settings.

This study was devised to follow charge development on surfaces of α- and γ-FeOOH submicron-sized particles in mixtures of NaCl and $NaClO_4$ electrolytes. Surface charge and zeta potential data notably show that end-member NaCl and $NaClO_4$ properties, such as capacitance and shear plane position, cannot be used to predict mixed systems (Fig. 1). Experiments on FeOOH particles of varied aspect ratios moreover point to important surface structural controls on these results as well. Mixed electrolyte systems are therefore likely to develop distinct interfacial water structures and ionic distributions.

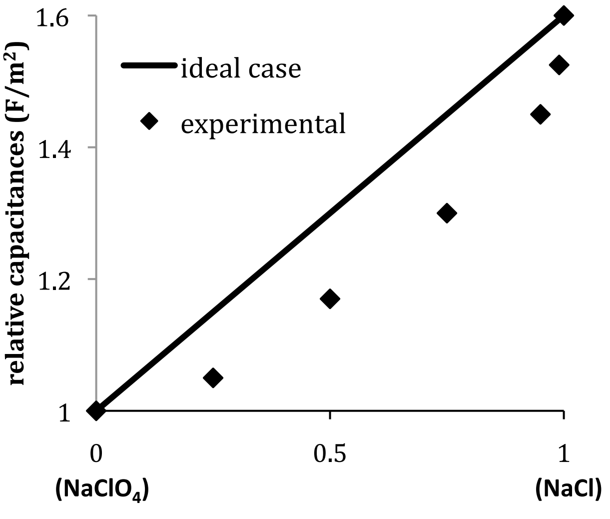

Figure 1: Relative capacitances of synthetic goethite (α-FeOOH) in mixed aqueous solutions of NaCl and $NaClO_4$. Total ionic strength 0.1M $Na(Cl,ClO_4)$.

Comparative genome analysis of *Metallosphaera yellowstonensis* and a novel iron-oxidizing sulfolobales from Yellowstone National Park

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Draft genomes have been completed for the iron and sulfur-oxidizing crenarchaea *Metallosphaera yellowstonensis* and Sulfolobales sp. strain MK5 (a novel member of the order Sulfolobales exhibiting only 89% 16S rRNA similarity to the closest *Sulfolobus* spp.). Both strains were obtained from a ferric iron mat within an acidic geothermal spring in YNP. This study compares the putative genes involved in iron and sulfur oxidation, heavy metal resistance, carbon fixation, and oxygen reduction between the two strains and with a diverse group of known iron-oxidizing acidophilic prokaryotes.

The draft genomes of each of these organisms contain sequences similar to putative iron-oxidizing open reading frames found in *M. sedula* and *S. tokodaii*, including a novel *fox* terminal oxidase gene cluster, a multicopper oxidase (*mco*), and the *cbs*AB-*sox*L2N operon. These genes differ considerably from the hypothesized cytochromes found in the genomes of *Acidithiobacillus ferrooxidans* and *Leptospirillum* sp. Group II. *M. yellowstonensis* and strain MK5 contain conserved heterodisulfide (*hdr*) gene clusters believed to be involved in the oxidation of elemental sulfur, as well as sequences that code for proteins involved in the oxidation of sulfide (*sqr*), sulfite (*som*), and thiosulfate oxidation (*tqo*). Multiple copies of the heme copper oxidase (HCO) subunit I were identified in both draft genomes. *M. yellowstonensis* also contains a *bd*-type terminal oxidase not found in other known members of the Sulfolobales.

M. yellowstonensis and strain MK5 are similar to other Sulfolobales in regards to genes involved in CO_2 fixation (i.e. 3-hydroxypropionate/ 4-hydroxybutyrate cycle) and heavy metal resistance; however, *M. yellowstonensis* is the only known archaeon to contain a methyl mercury lyase (*mer*B) gene. Analysis of gene sequence data suggest that, in addition to the diversity of HCO's, *M. yellowstonensis* and *Sulfolobales* strain MK5 exhibit novel mechanisms of iron oxidation, sulfur metabolism, autotrophy, and heavy metal resistance, all of which are consistent with the observed distribution of these organisms in high-temperature habitats of YNP.