Surface reactivity of acidophilic and alkaliphilic bacteria as determined by potentiometric titrations

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The speciation and mobility of metals in the environment can be influenced by many factors, including adsorption onto bacterial cell wall functional groups. A number of studies have documented similarities between bacterial species in terms of their deprotonation and metal uptake behaviors, but these studies have involved genetically similar bacterial species that do not necessarily reflect the diversity of bacteria found in nature. Ginn and Fein (2008) studied the binding properties of a wider genetic range of bacteria, noting that the only species that exhibited markedly different behavior than the others was an acidophile, *Acidophilium angustum*. The acidophile exhibited a significantly lower proton buffering capacity than the other species, and lower extents of metal adsorption as well. In this study, we determine how generalizable these results are by measuring the binding properties of two additional acidophilic species, and we extend the survey of binding behaviors of extremophile bacteria to include the first studies of alkaliphilic species.

We conducted potentiometric titrations to determine the proton binding capacities of each bacterial species studied. The titrations were conducted using a 0.1 M $NaClO_4$ electrolyte to buffer ionic strength, and under a N_2 atmosphere to eliminate CO_2 interference, The titration data were interpreted using discrete site non-electrostatic surface complexation models so that the calculated acidity constants and site concentrations could be directly compared to those determined using the same approach for a range of bacterial species already studied.

The potentiometric titration data indicate higher buffering capacities for the species in this study than that measured for *A. angustum* by Ginn and Fein [1]. The titration data in this study require 3 discrete sites to account for the buffereing behavior, whereas data for *A. angustum* required only a 1 site model. Our results suggest that the surface reactivity of bacteria from highly acidic or alkaline environments can vary significantly, so these species must be studied separately if the effects of cell wall adsorption is to be modeled in these systems.

[1] Ginn B. R. and Fein J. B. (2008) *Geochim. Cosmochim. Acta* **72**, 3939-3948

Volatile contents of Belingewe Komatiites: Mantle volatile contents and the effects of degassing

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Komatiite and associated magmas provide primary constraints on the thermal structure and composition of the Archaean and Proterozoic mantle, although there remain important questions regarding volatile abundances in primary komatiite liquids and the tectonic environment of komatiite generation.

We present herein new data for H-C-S-F-Cl contents of olivine-hosted melt inclusions from 2.7 Ga komatiite lavas from Belingwe, Zimbabwe. Inclusions are hosted in polyhedral olivine phenocrysts, and were trapped at temperatures in excess of 1300°C from primary melt composition with ~23 wt.% MgO. There is no evidence that boundary layer trapping resulted in significant modification of melt composition during trapping. Inversion of primary TiO_2 contents suggests ~30-40% melting of a depleted mantle composition.

Our data include measurements of CO_2 contents and thus allow us to assess the effect of degassing. Melt inclusions have up to ~150 ppm CO_2, sufficient to rule out significant loss of H_2O or other volatiles by open or closed system degassing, and suggest trapping occurred late within the magmatic history within at shallow crustal levels (~2 km depth). Water contents measured to date range between 0.4-0.6 wt.%, equivalent to ~700-1200 ppm H_2O in the mantle source. This is significantly greater than modern DMM, and lower than typical arc magmas, but within the range of modern back-arc basalts. Chlorine contents range from ~500-700 ppm, and source Cl and Cl/K are also significantly enriched over DMM values. Sulfur contents are relatively low, and support models which suggest komatiite magmas were undersaturated with respect to sulfur. Sulfur/TiO_2 and F/TiO_2 ratios also overlap those of the modern DMM.

Our data suggest komatiite generation from melting of “damp” mantle, possibly with analogies to modern back arc environments. This might also explain Cl enrichment, although trace element contents show only slight elevation of LILE/HFSE ratios over those of MORB.