Measurement of Environmental Biological Iron (II) - Oxidizing Activity

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Biological Fe^{2+}-oxidizing activity coupled to cellular processes (e.g. respiration) was measured under microaerophilic conditions for two environmental samples (PWC-W and PWC-E) containing iron-oxidizing bacteria (FeOB) and associated biogenic iron oxides from iron seeps in Virginia. Measurements were made in real time using a voltammetric microelectrode. Biological activity was determined as the difference between oxidation rates for live and azide treated samples. The azide treatment completely inhibited cellular respiration, thus measuring both chemical oxidation and exogenous binding of Fe^{2+} to microbial and iron oxide surfaces. Biological Fe^{2+}-oxidizing activity accounted for up to 75% of the total Fe^{2+} oxidation at these sites. Pseudo-first order kinetic rates for biological activity were greater than estimated chemical oxidation rates by 1 and 2 orders of magnitude for the two sites.

The PWC-W site was dominated by the helical stalks of the FeOB genus *Gallionella* whereas the PWC-E sample was comprised mainly of oxide-encrusted sheaths produced by the FeOB genus *Leptothrix*. Quantitative real-time PCR assays corroborated morphological iron oxide analysis indicating *Gallionella*, *Leptothrix*, or another FeOB, ES-1 type, organisms were present in the PWC samples.

Kinetic and molecular data suggest FeOB dominated iron-oxidation within these circumneutral Fe^{2+} seeps. The methods developed here will allow further investigations that assess biological activity and constrain conditions for lithotrophic Fe-oxidation in iron-rich environments on Earth, as well as other planets or planetary bodies in the solar system.

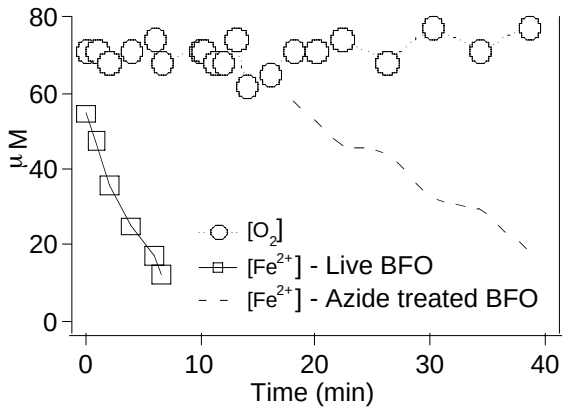

Figure 1. Fe^{2+} consumption by iron-oxidizing bacteria and associated biogenic iron oxides (BFO) before and after azide addition. Fe^{2+} and O_2 concentrations were measured concurrently with cyclic voltammetry using a solid-state Au/Hg electrode.