Iron cycle in an neutrophilic iron seep

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The Iron cycling in an ph-neutral groundwater iron seep in Alabama was investigated as a model for subsurface Fe redox cycling on Mars.
The precipitated iron minerals contained 82.4 mmol $Fe(III)_{total}$ L^{-1} with 90% of $Fe(III)_{amorph}$. The Fe(II)-content was low (200 µmol/L). Culture-based enumeration studies revealed high MPN for aerobe ($9.09E^6$ – $1.98E^8$) and anaerobe bacteria ($4.94E^7$ – $1.08E^9$). Comparable numbers of Fe(III)-reducing ($1{,}16E^3$ - $9{,}81E^3$) and Fe(II)-oxidizing ($3{,}34E^4$ - $2{,}41E^5$) microorganisms were obtained. Significant higher MPN's for FeRB were obtained when iron seep Fe(III)-minerals ($3{,}32E^5$ – $2{,}39E^6$) were used instead of synthetically ferrihydrite ($7{,}37E^3$ – $5{,}32E^4$). Molecular investigations revealed a variety of heterotrophic and autotrophic phylotypes like ammonium (35%) and Fe(II)-oxidizers (13%) from the beta-proteobacteria. Phylotypes similar to *Geobacter* or *Shewanella* were not obtained.
Non-stimulated Incubation of seep material under anoxic conditions revealed a constantly Fe(III)-reduction of 0,011 µmol mL^{-1} hr^{-1} over 20 days. Approximated calculation of a Fe(II)-oxidation rate for the Fe(II)-oxidizing population in the seep material with an Fe(II)-oxidation rate of ~10^{-7} µmol Fe(II) $cell^{-1}$ hr^{-1} from strain TW2 (beta-proteobacterium isolate from a freshwater wetland) resulted in a rate of 0.01 µmol mL^{-1} hr^{-1} similar to the observed Fe(III)-reduction rate in the iron seep.

Conceptually these results are consistent with those from experimental co-cultures, and suggest that a coupling of microbial Fe oxidation and reduction takes place in the iron seep materials. This iron seep systems provide a model for how microbially-catalyzed Fe redox cycling could take place in subsurface Martian environments where reduced fluids/solids contact oxygen-bearing water or water vapor.