The contribution of magnetotactic bacteria to reduced iron flux in stratified marine environments

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Magnetotactic bacteria (MTB) biomineralize membrane-bound magnetic iron minerals (magnetite, Fe_3O_4 or greigite, Fe_3S_4) and are globally abundant in the suboxic/anoxic portions of chemically stratified marine and freshwater environments, but their contribution to iron sequestration has not been previously quantified. We developed a molecular assay (quantitative PCR) to enumerate magnetite- and greigite-producing MTB in a stratified coastal pond (Salt Pond, Falmouth, MA) and used TEM imaging of magnetosomes to quantify the cellular iron content. Abundance and Fe content data were combined to produce estimates of MTB contribution to total Fe flux.

Our results show that magnetite- and greigite-producing MTB occupy distinct niches dictated at least partially by water chemistry and the thermodynamics of mineral synthesis. MTB in Salt Pond are present at an average concentration of 10^2-10^4 per ml with occasional blooms reaching 10^5 cells ml^{-1} and contain 10^{-13} to 10^{-14} g Fe per cell. We calculated the the contribution of MTB to the total flux of reduced Fe out of Salt Pond as follows: depth-integrated concentration of MTB * Fe content per cell * chemocline width * number of MTB populations per year. We estimate that MTB contribute $2.5*10^{-4}$ μg Fe cm^{-2} yr^{-1} to the flux of reduced iron out of the Salt Pond chemocline [1]. Similar calculations using parameter estimates for larger stratified basins (the Pettaquamscutt Estuary, RI and the Black Sea) suggest that minerals produced by MTB could constitute up to 13% of the total flux of reduced iron out of the chemocline in these environments.

We propose a model of the "MTB iron pump" in which some fraction of magnetosomes produced by MTB are recycled within the chemocline and some fraction accumulates in sediments. A combination of molecular and mineralogical studies of MTB is required to understand the operation of this mechanism. Our intial studies of MTB communities in modern environments suggest that MTB could be major unrecognized contributors to geochemically important fluxes of reduced Fe.

References

[1] Simmons S.L. , Bazylinski D.A., and Edwards K.J. (2006) *Submitted*.