Chemical signature of magnetotactic bacteria

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Magnetotactic bacteria (MTB) are ubiquitous aquatic microorganisms that synthesize intracellular nanocrystals of magnetite [Fe(II)Fe(III)$_2$O$_4$] or greigite [Fe(II)Fe(III)$_2$S$_4$] in organelles called magnetosomes. They live under microoxic or anaerobic conditions. Magnetosomes allow MTB to swim along the Earth's geomagnetic field lines toward oxygen optimum conditions. This ability might have been preserved through geological time since their putative emergence 2.5-3 Ga ago, according to phylogenetic, genetic and proteomic studies [1]. Banded iron formations (BIFs) dating to the Great Oxidation Event (~2.45 Ga) and carbonate globules from the Martian meteorite ALH84001 (~3.9 Ga) host nanocrystals of magnetite that have been suggested to be produced by MTB. However, criteria used for MTB identification in these rocks are essentially limited to morphological description (e.g. size and shape) of nanomagnetite. In this study, we aim at establishing specific chemical signatures of MTB magnetites to distinguish them from abiotic ones as well as from extracellular magnetite produced by other iron-metabolizing bacteria [Fe(II)-oxidizing and Fe(III)-reducing bacteria]. We measured major and traces elements concentration in biological magnetites produced by an oceanic MTB, *Magnetovibrio blakemorei*, strain MV-1 in various conditions of laboratory cultures. The calculated partition coefficents (K_D) representing the enrichment of chemical elements in the magnetite relative to the growth medium show a strong distinction between biotic and abiotic magnetite for Molybdenium ($K_{D,\ MV\text{-}1}$(Mo) = 2.10^{-4} (+/- 1.10^{-5}) while $K_{D,\ abiotic}$ (Mo) = 9.10^{-9} (+/- 3.10^{-9})) and Tin ($K_{D,\ MV\text{-}1}$(Sn) = 5.10^{-2} (+/- 2.10^{-2}) while $K_{D,\ abiotic}$ (Sn) = 1.10^{-8} (+/- 6.10^{-10})). A previous study showed similar enrichments in Mo and Sn in the freshwter *Magnetospirillum magneticum* (AMB-1) [2], which may indicate that these two elements could be jointly used as a tracer of MTB species. We are now exploring a range of elements to properly define the chemical composition of nanomagnetites produced by MTB, including some bacteria from natural environments with different morphotypes of magnetosomes.

[1] Lin *et al.* (2017) *PNAS* **114**, 2171-2176
[2] Amor *et al.* (2014) *PNAS* **112**, 1699-1703

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