# Chemical purity of magnetite produced by magnetotactic bacteria

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Magnetite ($Fe_3O_4$) is a widespread iron oxide found at the Earth surface. Some magnetite natural samples have been proposed to represent magnetotactic bacteria (MTB) fossils. MTB perform biomineralization of intracellular magnetite nanoparticles under a controlled pathway. These bacteria are ubiquitous in modern natural environments. However, their identification in ancient geological materials remains challenging. Together with physical and mineralogical properties, the chemical composition of magnetite was proposed as a promising tracer for bacterial magnetofossil identification, but this had never been explored quantitatively and systematically for many trace elements. In the present work, we determined the incorporation pattern of 34 trace elements in magnetite in both cases of abiotic aqueous precipitation and of production by the magnetotactic bacterium *Magnetospirillum magneticum* strain AMB-1. We show that, in biomagnetite, most elements are at least 100 times less concentrated than in abiotic magnetite. In contrast, molybdenum and tin are preferentially enriched in magnetite produced by MTB relative to abiotic magnetite. The difference in incorporation patterns between abiotic and biotic magnetite can be explained by a biological control of chemical element transfer from the external aqueous solution to magnetite. The interior of cells is usually characterized by elemental concentrations very different from those in the outer medium. Elements with important physiological functions are actively regulated in the cytoplasm, while those being too concentrated and/or toxic are pumped outward from the cell. We propose that the strong relative depletions in most trace elements and specific enrichments in Mo and Sn can be used as a reliable chemical biomarker to test the origin of magnetite potentially produced by MTB.