

Partitioning of trace and minor elements between magnetite and aqueous fluids: Experiments and modeling

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Magnetite (Fe_3O_4) is one of the most important biominerals found in anoxic zones of soils and sediments. Its content in trace elements depends on the composition of the medium from which it grew and on the elemental partitioning between the parent medium and the mineral. In turn, trace element analyses of magnetites could provide precious information on the media and processes that govern their formation. In order to better understand the trace and minor elements incorporation in biomineralized magnetites, we determined, using ICP-MS, the incorporation pattern of 34 trace elements in synthetic magnetites, of about 10 nm, synthesized in aqueous solution under controlled conditions. The partitioning coefficients follow trends consistent with a model of elastic energy penalty in magnetite, which mask crystal field effects. A geochemical code (CHESS) is adapted to model these results and to predict trace element contents of magnetite in a large range of biogeochemical contexts. This modeling is then compared to the results of a novel analytical approach that allowed us to measure the contents in the same trace elements of magnetites obtained from cultures of magnetotactic bacteria [1]. This comparison is then used to infer some geochemical characteristics of the biomineralization medium of the magnetites produced in bacterial magnetosomes showing that the trace element content of magnetites may act as a valuable reporter of the biomineralization medium.

[1] Amor M, Busigny V, Durand-Dubief M, Tharaud M, Ona-Nguema G, Gélabert A, Alphandéry E, Menguy N, Benedetti MF, Chebbi I, and Guyot F (2015) Chemical signature of magnetotactic bacteria. *PNAS* **112**, 1699-1703.