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Environmental parameters affect the physical properties of fast-growing magnetosomes

Damien Faivre,[1,*] Nicolas Menguy,[2] Mihály Pósfai,[3] and Dirk Schüler[1,4]

[1]Department of Microbiology, Max Planck Institute for Marine Microbiology, Celsiusstr. 1, 28359 Bremen, Germany
[2]Institut de Minéralogie et Physique des Milieux Condensés, UMR 7590, CNRS, Universités Paris 6 et 7, IPGP, 140 rue de Lourmel, 75015 Paris, France
[3]Department of Earth and Environmental Sciences, University of Pannonia, POB 158, 8200 Veszprém, Hungary
[4]Microbiology, Department of Biology, LMU München, Maria-Ward-Strasse 1a, 80638 München, Germany

Abstract

Magnetotactic bacteria are known to mediate the formation of intracellular magnetic nanoparticles in organelles called magnetosomes. These magnetite crystals are formed through a process called biologically controlled mineralization, in which the microorganisms exert a strict control over the formation and development of the mineral phase. By inducing magnetite nucleation and growth in resting, Fe-starved cells of *Magnetospirillum gryphiswaldense*, we have followed the dynamics of magnetosome development. By studying the properties of the crystals at several steps of maturity, we observed that freshly induced particles lacked a well-defined morphology. More surprisingly, although the mean particle size of mature magnetosomes is similar to that of magnetosomes formed by constantly growing and Fe-supplemented bacteria, we found that other physical properties such as crystal-size distribution, aspect ratio, and morphology significantly differ. Correlating these results with measurements of Fe uptake rates, we suggest that the expression of different faces is favored for different growth conditions. These results imply that the biological control over magnetite biomineralization by magnetotactic bacteria can be disturbed by environmental parameters. Specifically, the morphology of magnetite crystals is not exclusively determined by biological intervention through vectorial regulation at the organic boundaries or by molecular interaction with the magnetosome membrane, but also by the rates of Fe uptake. This insight may contribute to better define biomarkers and to an improved understanding of biomineralizing systems.

Keywords: Biomineralization, magnetotactic bacteria, magnetosomes, magnetite, morphology