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Precipitation of magnetite in presence of a magnetosome membrane protein

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The synthesis of magnetite by prokaryotes has raised the interest of many researchers, particularly in magnetite biomineralization by magnetotatic bacteria. These bacteria are a diverse group of prokaryotes that share the capacity to biomineralize magnetosomes and the ability to align along the Earth magnetic field and to actively swim along these lines. The magnetosomes are intracellular vesicles composed of a magnetic mineral (magnetite or greigite) surrounded by a lipidic bilayer membrane. Thanks to the production of magnetosomes these bacteria reduce to one dimension the search for the oxic-anoxic interface (OAI) within water columns or sediments, which contains the optimal oxygen concentration they need to live. Bacteria exquisitely control magnetite biomineralization in the magnetosomes, and that control imprints the minerals with specific features that have prompted the use of these magnetites as magnetofossils and as ideal for the application in nanotechnology: in electronics, in tumor therapy, biosensors, drug delivery systems… For these applications, the nanoparticles of magnetite must be very homogeneous with a specific size and morphologies. The production of this kind of magnetite by inorganic methods is very expensive. However, the magnetites synthetized by magnetotactic bacteria have all of these properties, and have proven to be an excellent material in nanotechnology (Amemiya et al., 2007). Nevertheless, there are still problems that challenge these applications and that could be partially resolved if we had a better understanding of the bacterial biomineralization process.
One of the most intriguing and unresolved problems is the specific, out of equilibrium morphology of the magnetites produced in the magnetosomes. Some authors postulate that this morphology could be the result of the interaction of the crystals with proteins from the magnetosome. To further elucidate this issue, we intend to study the potential interaction between one magnetosome protein (MamC) produced by the magnetotactic coccus MC-1, and the magnetite crystal. The first problem to overcome is purify MamC and such purification is not straightforward. We have purified the protein in native conditions and we have precipitated inorganic magnetite in presence of MamC and in the absence of the protein (control experiment) at 25ºC and in anaerobic conditions using an anaerobic chamber. TEM was used to study the size and morphology of the biominerals. Both size and morphology are greatly affected by the presence of the protein in the medium where the crystal grows. Magnetite precipitated in the presence of MamC is bigger (25 nm) and has a well defined morphology than that precipitated in the control experiment (100-200nm, rounded). These results show that MamC has a role on the nucleation of the magnetite crystals that result in a slower, best controlled nucleation process.