Evolutionary history of controlled biomineralization of magnetite and greigite in magnetotactic bacteria

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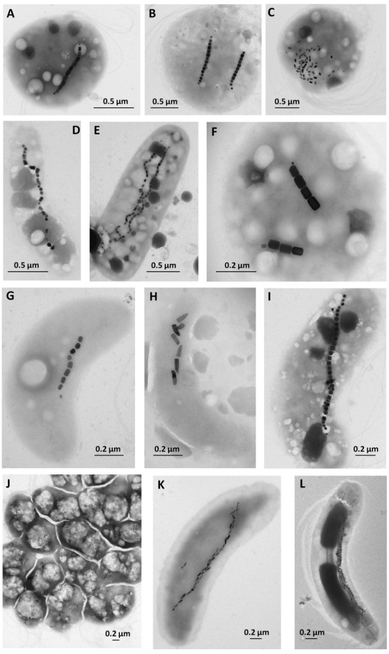

Figure 1: Transmission electron micrographs of magnetotactic bacteria isolated from the same sampling bottle collected from the Mediterranean Sea at the Mejean Calanque near Marseille, France.

Magnetotactic bacteria (MTB) are defined as motile prokaryotes whose swimming direction is guided by magnetic fields, including the Earth's geomagnetic field. This behavior, named magnetotaxis, results from the synthesis of magnetosomes which are composed of a magnetic mineral crystal, either an iron oxide (magnetite Fe_3O_4) or iron sulfide (greigite Fe_3S_4), surrounded by a lipid bilayer membrane. The process of magnetosome biomineralization includes (i) the choice of mineral composition, (ii) the control over the size and morphology of the crystals and (iii) their position within the cell. This process has been refined and optimized in the course of evolution, especially considering that it probably originated first as cells taking up large amounts of iron. At some point, the genes encoding magnetosome membrane proteins would have then evolved toward a controlled biomineralization process leading to the magnetosome mineral phase and the first MTB. The primitive lines of MTB that acquired the original pool of genes necessary for magnetosome formation seem to have evolved differently in different phylogenetic groups that contain MTB. This leads to different magnetosome crystal compositions and morphologies and the emergence of new genes involved in magnetosome formation, thus explaining the great diversity of MTB (Figure 1). During this presentation I will introduce the recent insights into the evolution of magnetosomes from a biological to a crystallographic point of view.