doi:10.1017/S1431927611001577
Microsc. Microanal. 17 (Suppl 2), 2011

Magnetotactic Bacteria Containing Phosphorus-Rich Inclusion Bodies

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Magnetotactic bacteria are a group of bacteria that can be characterized ultrastructurally by their ability to biomineralize a chain of membrane bound crystals of magnetite (Fe_3O_4) or greigite (Fe_3S_4); these structures are called magnetosomes. These structures are used by magnetotactic bacteria to passively align themselves with Earth's magnetic field allowing them to navigate within their environment, which typically consists of freshwater or marine sediments. Magnetotactic bacteria are also capable of producing other sub-cellular structures in their cytoplasm by accumulating elements or molecules such as polyhydroxybuterate [1], phosphorus granules [2], as well as accumulating heavy metals from the environment [3].

In this study we isolated magnetotactic bacteria from the Olentangy River Wetland in Columbus, Ohio and analyzed the cells using an FEI Tecnai F20 TEM equipped with an X-ray detector. We found rod-shaped magnetotactic bacteria containing a single chain of magnetosomes running the length of one side of the cell, as well as two symmetric opaque structures at the ends of the cells (Figure 1). Energy-dispersive X-ray analysis (EDX) revealed that the inclusions were phosphate-rich, but also contained smaller amounts of other elements such as Mg, Ca, and K (Figure 2).

The purpose of phosphate inclusions in magnetotactic bacteria is not exactly understood but they could be used to detoxify metals such as Zn, Mn, and Sr in the environment [3]. However, the ions (Ca^{2+}, Mg^{2+}, and K^{1+}) contained within the inclusion bodies in this study are not toxic to the microorganism. Further investigation is needed to elucidate why these bacteria are accumulating specific ions in the inclusions.

References

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[4] We thank Henk Colijn of the Campus Electron Optics Facility at The Ohio State University for his assistance with the image collection and X-ray analysis.

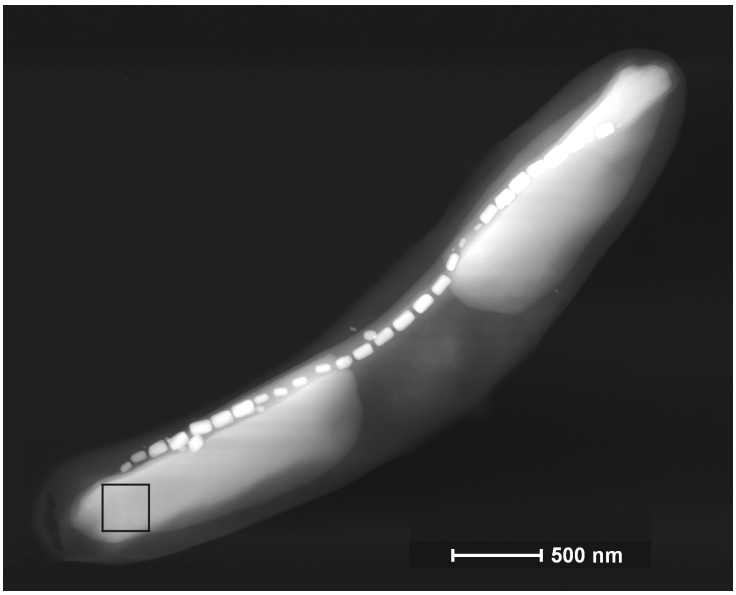

FIG. 1. An example of a magnetotactic bacterium isolated from the Olentangy River Wetland in Columbus, Ohio. The crystalline structures that run the length of the cell are magnetosomes (membrane bound magnetite crystals) and the two large opaque masses on each half of the cell are phosphate inclusion bodies. The black box represents the area where the X-ray analysis was performed in Figure 2.

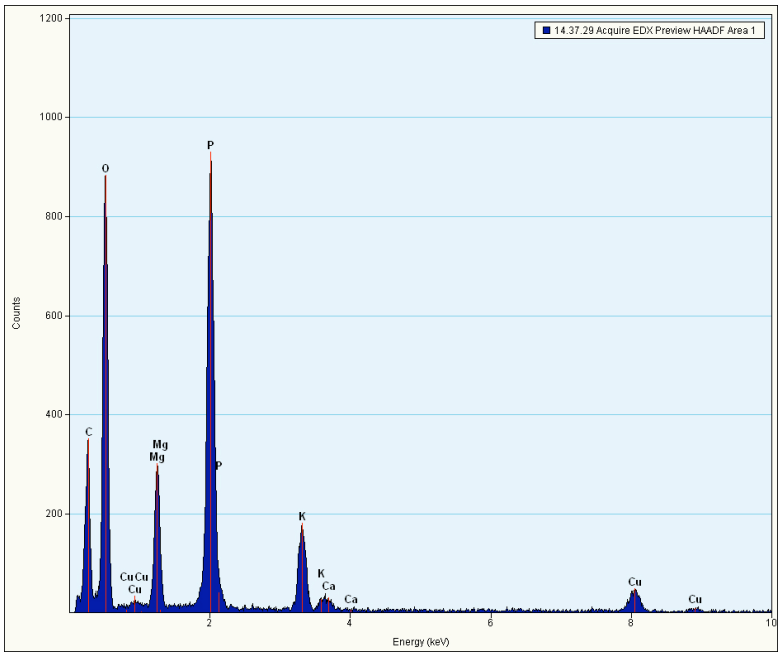

FIG. 2. Energy-dispersive X-ray analysis (EDX) from a small region (black box) of one of the opaque inclusion from the magnetotactic bacteria in Figure 1. The inclusion contains a large amount of phosphorus with smaller amounts of magnesium, potassium, and calcium. The copper peak is presumably from the copper grid used for the sample.

https://doi.org/10.1017/S1431927611001577 Published online by Cambridge University Press