Crystal growth of bullet-shaped magnetite in magnetotactic bacteria of the Nitrospirae phylum

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Magnetotactic bacteria (MTB) are known to produce single-domain magnetite or greigite crystals within intracellular membrane organelles and to navigate along he Earth's magnetic field lines. MTB have been suggested as being one of the most ancient biomineralizing metabolisms on the Earth and they represent a fundamental model of intracellular biomineralization. Moreover, the determination of their specific structure and morphology is essential for paleoenvironmental studies. Yet, the mechanisms of MTB biomineralization remain poorly understood, although this process has been extensively studied in several cultured MTB strains in the Proteobacteria phylum. Here, we present a comprehensive TEM study of magnetic and structural properties down to atomic scales on bullet-shaped magnetites produced by the uncultured strain MYR-1 belonging to the Nitrospirae phylum, a deeply branching phylogenetic MTB group. We observed a multiple-step crystal growth of MYR-1 magnetite: initial growth forming cubo-octahedral particles, subsequent anisotropic growth and a systematic final elongation along [001] direction. During the crystal growth, one major {111} face is developed and preserved at the larger basal end of the crystal. The basal {111} face appears to be terminated by a tetrahedral–octahedral-mixed iron surface, suggesting dimensional advantages for binding protein(s), which may template the crystallization of magnetite. This study offers new insights for understanding magnetite biomineralization within the Nitrospirae phylum.

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