

Nano-sized biogenic iron oxides produced by neutrophilic Fe-oxidizing bacteria and its implications for biogeochemical cycling

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Neutrophilic microaerophilic Fe-oxidizing bacteria (NMFeOB) are thought to play a significant role in global biogeochemical cycling of Fe and associated elements. They are commonly found at redox boundaries in both of freshwater and marine iron-rich environments, and produce extracellular iron biominerals that interact with various elements. However, ecophysiology of NMFeOB is still poorly understood due to the difficulty of cultivation. Recently, *Ferriphaselus amnicola* strain OYT1 and *Ferriphaselus* sp. strain R-1, which produce a unique twisted-ribbon-like extracellular iron biomineral structure called a stalk, have been reported (Krepski et al., 2012; Kato et al., 2014). The present study demonstrates the strains OYT1 and R-1 also produce extracellular nano-sized biogenic iron oxides (nanoBIOS), which are morphologically distinct from stalks. Energy dispersive X-ray spectroscopy indicates that the nanoBIOS contain P, as well as the stalks. Given the chemical and morphological characteristics, nanoBIOS may contribute to P, Fe and other metal transport in the environment as a vector. Furthermore, the first genome sequencing of stalk-forming NMFeOB was performed in the present study. Comparative genomics propose potential genes involved in the formation of stalks and nanoBIOS, which are similar to genes involved in extracellular polysaccharide production, and potential genes in iron oxidation, which have been previously suggested as key iron oxidation genes in other NMFeOB. These genes can be used as marker genes for detection of NMFeOB producing iron biominerals. Overall, the detailed microscopy and first genomic analysis of the freshwater stalk-forming NMFeOB provide novel insight into the ecophysiology and biomineralization of enigmatic NMFeOB.

Keywords: Fe-oxidizing bacteria, Nano-sized iron oxides, Biogeochemical cycling