Effects of *c*-type cytochrome-deleted mutants of *Shewanella oneidensis* MR-1 on iron reduction and biomineralization

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It is widely recognized that *Shewanella oneidensis* MR-1 evolves an Mtr (i.e. metal-reducing) extracellular-electron-transfer pathway for iron reduction under anoxic conditions. The key electron-transfer proteins in the Mtr pathway have been isolated and purified, however, the specific functions of each protein in reducing poorly crystalline hydrous ferric oxide (HFO) and concomitantly, influencing the process of biomineralization are still rarely reported. In this study, we investigated the effects of *c*-type cytochrome-deleted mutants of *Shewanella oneidensis* MR-1 on reduction of HFO and the following mineralization. The results indicated that while the reduction rate of HFO after knocking out MtrD, MtrF and OmcA retained at the similar level compared with the wild type (wt), HFO reduction capability by the strains lacking CymA and MtrA decreased dramatically. The secondary minerals of HFO were characterized using X-ray diffraction, Fourier transform infrared spectra and scanning electron microscopy. The results showed that goethite and hematite were the main forms of secondary minerals in the first two days in all the treatments, and then hematite was fully converted into magnetite after six days in the four treatments of wt, Δ*mtrD*, Δ*mtrF* and Δ*omcA*; for the treatment of Δ*mtrC*, magnetite began to appear from the sixth day; for the treatments of Δ*mtrA* and Δ*cymA*, no magnetite was observed at all times. The study correlated the geochemical processes (iron reduction and biomineralization) with the electron transfer chain of an iron reducing microorganism, which may help the understanding of the natural microbe-mineral interactive processes.

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