Contrasting Effect of Fe(II) Oxygenation on the Subsequent Fe(III) Bio-reduction: Bactericidal Effect versus Fe(III) Bio-availability Enhancement

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The interplay of Fe(II) oxygenation and Fe(III) bio-reduction occurs widely in both natural and engineered systems. Although Fe(II) oxygenation and Fe(III) bio-reduction has been extensively investigated, the impact of Fe(II) oxygenation on the subsequent Fe(III) bio-reduction is overlooked, which limits our understanding of Fe cycling. This study aimed to unravel the impact of Fe(II) oxygenation on the survival of a typical facultative anaerobic dissimilatory Fe(III)-reducing bacterium, Shewanella oneidensis strain MR-1 (MR-1), as well as on the subsequent Fe(III) bio-reduction. MR-1 cells at 2.0×10^7 CFU/mL were killed by 0.8–1.71 orders of magnitude upon oxygenating 0.1–0.5 mM Fe2+ at neutral conditions due to the production of reactive oxidants. Nevertheless, the subsequent bio-reduction of the in situ formed Fe(III) by the survived MR-1 was faster than the bio-reduction of the Fe(III) produced from Fe(II) oxygenation without bacteria by 2.0×10^7 CFU/mL fresh MR-1. The accelerated bio-reduction was mainly attributed to the enhancement of Fe(III) bio-availability and the remaining activity of dead cells. The impact of Fe(II) oxygenation on Fe(III) bio-reduction presents a cryptic mechanism for the biogeochemical cycling of Fe in redox-dynamic systems.