Biochemical mineral reduction through the porin cytochrome complex of *Shewanella oneidensis*

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Biological reduction of insoluble metal oxides such as goethite and hematite can occur during a process known mineral respiration. Microorganisms that are capable of mineral respiration include *Shewanella oneidensis* MR-1, a Gram negative bacterium that expresses an MtrCAB porin-cytochrome complex in the outer membrane in order to transfer electrons from the cell interior to the surface. Once at the surface of the cell electrons are transferred to insoluble minerals either directly or indirectly. In order to study the kinetics of the MtrCAB complex it was necessary to develop a system where electron transfer through the complex and into minerals could be monitored. We have generated a liposome system that contains a methyl viologen redox dye inside the liposomes, and MtrCAB embedded in the membrane. These liposomes can be charged with electrons in form of reduced methyl viologen and then mixed with terminal electron acceptors in order to measure the rate of methyl viologen oxidation through the MtrCAB complex. The role of different electron donors inside the liposome, and of alternative electron acceptors such as flavins are shown to affect the rates of electron transfer, and likely have an effect of the rate of mineral reduction in the environment.