Abstract

In this thesis, the hypothesis that photoautotrophic Fe(II)-oxidizing bacteria catalyzed the deposition of Banded Iron Formations (BIFs), an enigmatic class of ancient sedimentary rocks is explored. Ecophysiological, geochemical, genetic and biochemical approaches are taken to elucidate the molecular mechanism of photoautotrophic Fe(II) oxidation in an effort to identify molecular biosignatures that are unique to this metabolism and capable of being preserved BIFs. In an ecophysiological approach, we show that Fe(II) oxidation by these phototrophs proceeds at appreciable rates in the presence of high concentrations of H_2 when CO_2 is abundant. These findings substantiate a role for the involvement of these phototrophs in BIF deposition under the presumed geochemical conditions of the Archean. In a geochemical approach, we find that although phylogenetically distinct phototrophs fractionate Fe isotopes in a way that is consistent with Fe isotopic values found in Precambrian BIFs, it is unlikely that this fractionation can be used as a biosignature for this metabolism given its similarity to fractionations produced by abiotic Fe(II) oxidation reactions. In two distinct genetic approaches, we identify genes involved in Fe(II) oxidation in *Rhodopseudomonas palustris* TIE-1 and *Rhodobacter* SW2. Genes identified in TIE-1 encode a predicted integral membrane protein that appears to be part of an ABC transport system and a putative CobS, an enzyme involved in cobalamin (vitamin B_{12}) biosynthesis. Candidate genes on a cloned fragment of the *Rhodobacter* SW2 genome that confer Fe(II) oxidation activity to a non-oxidizing strain include those predicted to encode permeases and a protein with potential redox capability. Finally, in a preliminary biochemical approach, *c*-type cytochromes and other proteins that are exclusive or more highly expressed under Fe(II) growth conditions in TIE-1 and SW2 are identified in SDS-PAGE gels. The work described here furthers our search for a biosignature unique to photoautotrophic Fe(II) oxidation by providing mechanistic information on this metabolism.