ABSTRACT

An abstract of the dissertation of Mary Nichole Parenteau for the Doctor of Philosophy in Environmental Sciences and Resources: Geology presented May 9, 2007.

Title: Microbial biosignatures in high-iron thermal springs

Debate exists regarding whether abiotic or biotic mechanisms were responsible for the oxidation of Fe$^{2+}$ and the subsequent accumulation of ferric (Fe$^{3+}$) iron assemblages in Precambrian Banded Iron Formations (BIFs). Direct paleontological evidence for a microbial role in the deposition of BIFs has been sought in the occurrence of microfossils and lipid biomarkers in these structures.

This study has characterized the formation of such biosignatures in modern iron deposits. The metabolic impact of microbes on Fe$^{2+}$ oxidation in this system has previously been described (Pierson et al., 1999; Pierson and Parenteau, 2000). Cyanobacterial and filamentous anoxygenic phototrophic (e.g., Chloroflexus) microfossils, stromatolitic biofabrics, and lipid biomarkers were characterized using optical, scanning electron, and transmission electron microscopy; electron diffraction; X-ray diffraction; and lipid and compound-specific stable carbon isotope analyses.

TEM examination of the cyanobacterial cells revealed iron-mineralized carbonaceous microfossils that retained taxonomic features that allowed their identification to the species level. A robust suite of geologically significant lipid
biomarkers were identified and linked to the phototrophic source organisms. These biomarkers were found to survive microbial degradation and the earliest stages of diagenesis in the iron oxide deposits underneath the mats. Many of these modern biosignatures correlate with evidence preserved in the minerals and fabrics of ancient BIFs.

These biosignatures can be used to link modern microbial ecosystems to their fossilized equivalents preserved in the geological record. This type of fossil evidence can be used to infer the paleobiological role of microbes and paleoenvironmental conditions, and will establish a means to assess the microbial contribution to ancient iron deposits on Earth (e.g., BIFs) and, potentially, to those found on Mars.