Preservation of lipid biomarkers of Fe(III)-reducers and anoxicogenic phototrophic Fe(II)-oxidizers during exposure to high pressure and temperature (P/T)

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Background
The rock record is analyzed to search for traces of ancient life on Earth. The fractionation of carbon, sulfur and iron stable isotopes, sedimentary structures, microfossils, as well as molecular fossils (lipid biomarkers), are important indicators for past life. Molecular fossils are persistent compounds that often derive from membrane lipids, recording biological activity in ancient rocks. They provide information on past environmental conditions as well as dominant microbial metabolisms and have been found in sediments as old as 1.6 Ga [1] and 2.5 Ga [2].

So far, molecular fossils have not been detected in Archean Banded Iron Formations (BIFs). The formation of these sediments is still controversial. Most likely, the earliest BIFs were deposited in the absence of significant amounts of oxygen [3,4]. Anoxicogenic phototrophic Fe(II)-oxidizing bacteria were suggested being the most plausible mechanism for the deposition of the Fe(III) minerals under anoxic conditions [5]. Moreover, Fe(III)-reducing bacteria might have been involved in iron mineral transformation after deposition, as suggested by Fe and C isotope analyses [6].

Hence, Fe(II)-oxidizing and Fe(III)-reducing bacterial strains were chosen for a systematic biomarker study focusing on the fate of molecules during exposure to high pressure and temperature (P/T).

Current Research and Outlook
We present a new approach investigating the preservation of organic biomolecules of anoxicogenic phototrophic Fe(II)-oxidizing and anaerobic Fe(III)-reducing bacterial cells during exposure to diagenetic conditions (P/T) in inert gold capsules. Analysis of fatty acids, alcohols and hydrocarbons was done before and after P/T exposure, with a focus on fatty acids and cyclic terpenoids. We determined how these lipid compounds are affected at increasing temperatures in the absence and presence of iron minerals. In particular, the close association of the iron minerals with the cells appears to have an influence on the stability and preservation of biomarkers. Moreover, in the future we are planning to extend this method to identify carotenoid pigments in the phototrophic Fe(II)-oxidizers and study their preservation. In summary, the approach of simulating diagenetic and late-stage alteration will help identify stable and source-specific molecular fossils, and elucidate the likelihood of finding diagnostic biomarkers (and thereby evidence) for Fe-cycling bacteria in BIFs and other Fe-rich sediments.