Biogenicity of iron microfossils based on the morphology, physiology, and behavior of modern iron-depositing microbes

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Many iron-depositing microorganisms make distinctive iron mineralized filaments, which form iron mats in oxic-anoxic transition zones. These organisms and their mineral byproducts are found in environments ranging from wetlands to deep-sea hydrothermal vents. Iron-depositing microbes have likely been significant biogeochemical agents throughout much of Earth's history (e.g. deposition of iron formations). Iron filaments, similar to those of modern iron-depositing microbes, are found in the rock record. If we can confidently determine biogenicity and interpret physiology, these structures could be powerful tools to understand the microbiological and redox history of Earth. In our research, we are developing quantitative biogenicity criteria, based on multiple extant organisms and environments, and linked to physiology.

We investigated growth and biomineralization by the marine *Mariprofundus ferrooxydans* PV-1, as well as *Leptothrix*-like organisms enriched from a freshwater iron seep. Microbes were grown in opposing O_2/Fe(II) concentration gradients in flat glass growth chambers, which allowed for direct microscopic observation of growth. We documented microbial biomineralization by time-lapse light microscopy, and measured filament widths and directionality (as circular variance) over space and time. Microscopy was also coupled with solid-state electrode voltammetry to pair imaging with *in situ* measurements of chemical microenvironments. Our results show that microbial iron filaments display a narrow range of widths, and strong directional formation (showing small circular variance values) parallel to redox gradients. Biomineralization occurred under low oxygen levels, indicating the oxygen microenvironment of iron-depositing microbes. Filament widths and directionality varied over space and time, reflecting microbial growth and chemotaxis. We also made similar measurements on putative iron microfossils and found that they showed quantitatively similar patterns with regard to filament width and directionality. This work shows that iron filaments with a narrow range of widths, and directional formation can form the basis for strong morphological biosignatures. These signatures can be indicative of microaerophilic iron-depositing microbial activity and physiology in ancient environments. Strong biogenicity criteria will aid in the interpretation of iron microfossils, and will help us to piece together the redox history of Earth.

New water column profiles of dissolved thorium and protactinium in the western North-Atlantic

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The strength of the Atlantic Meridional Overturning Circulation (AMOC) is a major factor in the global thermohaline circulation system. Because of this central role of AMOC in the global climate system, it is important to have reliable tools to reconstruct the strength of deep water ventilation in general and of AMOC in particular during major phases of past climate variability. The basin-wide Atlantic ^{231}Pa/^{230}Th signature in sediment archives has been identified as a powerful tracer for the intensity of the AMOC in the past. The information on ocean circulation arises from an overall higher export rate of ^{231}Pa over ^{230}Th within NADW from the entire Atlantic basin to the Southern Ocean due to the somewhat lower particle reactivity of ^{231}Pa.

A fundamental complication for reliable applicability of this tool arises from the fact that there is a severe lack of data of these isotopes in the critical areas of the modern AMOC. Only very few ^{230}Th and ^{231}Pa profiles in the Labrador Sea, in the NE Atlantic, and in the tropical and South Atlantic have been published [1, 2, 3, 4].

To remove this gap, 14 water column profiles were sampled under trace metal clean conditions during the expedition of RV Pelagia (GEOTRACES Cruise GA02) on a transect following the North Atlantic deep water (NADW). At all stations the deepest sample was collected within the bottom nepheloid layer, providing information on the latest stage of signal development in the water column. Here we will present the first results on 5 profiles of dissolved ^{230}Th and ^{231}Pa along NADW between 15 and 55°N including also the crossover station Bermuda Atlantic Time-Series (BATS). With this study we aim to provide missing information of the factors controlling signal generation in order to answer the questions: What is the ^{231}Pa/^{230}Th isotope composition of the main water masses of the AMOC and how do the ^{230}Th and ^{231}Pa activities in NADW evolve on its way south and east? Can they be explained by ventilation or are there other controlling factors to identify such as the composition of suspended particles?

[1] Moran et al. (2002) *Earth Planet. Sci. Lett.* **203**, 999-1014.
[2] Moran et al. (1997) *Earth Planet. Sci. Lett.* **150**, 151-160.
[3] Moran et al. (1995) *Geophys. Res. Lett.* **22**, 2589-2592.
[4] Vogler et al. (1998) *Earth Planet. Sci. Lett.* **156**, 61-74.