Local environmental controls on microbial Fe(II)-oxidation in seafloor hydrothermal deposits

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Microaerophilic Fe(II)-oxidizing bacteria form distinct twisted extracellular stalks that may function as biosignatures and indicators of palaeo-redox conditions in jaspers and iron formations. The identification of Fe(II)-oxidizing bacteria in the rock record is dependent on knowledge of the geological setting and local environment of Fe-deposition. Here we aim to shed light on the environmental factors governing microbial Fe(II)-oxidation and biomineralization by combining molecular, textural and geochemical analyses of modern stratified low-temperature hydrothermal Fe-deposits at the Jan Mayen Vent Fields, Arctic Mid-Ocean Ridge. Our results reveal that Fe(II) supplied by low-temperature hydrothermal fluids is utilized by a microaerophilic Fe(II)-oxidizing community dominated by *Zetaproteobacteria*. The Fe-deposits are composed of biomineralized twisted stalks and branching sheaths with alternating MnO_2- and sediment-rich horizons, cm-sized domal internal cavities and fibrous, organic-rich laminae. All laminae show negative Eu-anomalies, reflecting the low-temperature origin of the hydrothermal source fluid. Elevated P and REE contents in the fibrous laminae indicate that Fe(III)-reduction takes place in the underlying sediments and that hydrothermal fluid pulses supply recycled Fe(II) and adsorbed elements to the seafloor. Variations in textures and chemistry furthermore suggest that fluctuations in hydrothermal fluid discharge exert the primary control on the formation of laminae and constrain the spatial distibution of biomineralized extracellular stalks. We suggest that fossil low-temperature hydrothermal deposits represent the most promising archives for microaerophilic Fe(II)-oxidizing bacteria in the rock record. These deposits may be identified based on a combination of twisted and branching filament morphologies, Eu-depleted REE patterns and synchrounous interlaminar variations in filament associations and contents of REE, P and MnO_2.