Geochemical signature of microbial activity during the deposition silica-stromatolite according to REE behaviour and Zr-Hf relationship

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Interactions between organic and inorganic species during the deposition of silica-stromatolites and associated microbial mats under hydrothermal conditions have been highlighted according to geochemical REE behaviour coupled to Zr-Hf fractionations.

In the studied system, dissolved SiO_2 derived from the leaching of outcropping volcanic rocks during interactions with hydrothermal fluids represents the raw material allowing to the deposition of stromatolites under the effects of severe microbial activity. At the same time microbial colonies also produce large amount of extracellular polymeric substances (EPS) that compete against bacterial surface into fractionating REE, Zr and Hf with respect to dissolved phase. Onto bacterial cell membranes (enriched in stromatolites) both specific polyphosphate binding sites and non-specific carboxyl O-donor groups occur differently partitioning HREE and MREE, depending on the REE/bacterial surfaces ratio [1]. EPS (occurring mainly in microbial mats) behave similarly to humic substances with respect to dissolved REE, due the similar nature of their surfaces where phenolic and carboxyl binging sites occur [2]. As a consequence REE, mainly Ce, are removed by EPS from dissolved phase and strongly enriched onto microbial mats. This process involves positive Ce anomalies and REE enrichments in the latter materials and consequently reduce the REE/bacterial surface ratio in forming stromatolites that preferentially bind HREE onto polyphosphate groups. During these processes a preferential Y and Zr with respect to Ho and Hf leads to higher Y/Ho and Zr/Hf ratios in microbial mats than in stromatolites suggesting that these ratios could represent a suitable geochemical signature of microbial activity in hydrothermal systems.

[1] Takahashi *et al*. (2005). *Chem Geol* ***219***, 53–67. [2] Pourret *et al*. (2008). *Chem Geol* ***251***, 120–127.

Controls of microbial nitrate/ nitrite respiration in polar marine sediments and implications for global climate change.

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An estimated 50 to 70% of the global removal of marine N occurs in sediments, and N removal from continental shelves comprises approximately half of the total sediment contribution. Despite the importance of nitrate/ nitrite respiration to the marine nitrogen cycle, surprisingly few studies have addressed the significance of temperature as a physical control of nitrate respiration. We have been studying the mechanisms and controls of N removal in permanently cold sediments collected in the fjords of Svalbard, Norway, for the past five years. As for other biogeochemical processes, rates of denitrification and anammox in cold (1-2 ºC) Arctic sediments approach those measured in temperate marine sediments. Denitrifying bacteria were isolated and shown to follow a psychrotolerant to psychrophilic growth response. Both denitrification and anammox exhibited temperature response characteristics consistent with a predominately psychrophilic community, but microbes with the anammox pathway appeared to be more adapted to permanently-cold sediments. Long term (weeks) warming experiments indicated that increases in temperature of 5 to 10 °C above *in situ* temperatures had little effect on the temperature response of denitrification and anammox, but increases of 25 °C shifted denitrification towards a predominately mesophilic community and eliminated anammox activity. When compared to previous temperature response data for other respiration processes in permanently cold sediments, it is apparent that there is considerable variability in Topt and activation energy, Ea, which may be driven by substrate availability. These results suggest that the effects of low temperature are modulated by other environmental factors to control rates of N removal in these Arctic coastal sediments.

Most recently, we have investigated the temperature regulation of microbial communities that mediate nitrogen removal in nearshore sediments over a 50° latitudinal gradient at subtropical (Gulf of Mexico), temperate (Wadden Sea), and Arctic (Svalbard) sites. The apparent activation energy of denitrification was two-fold higher in subtropical versus temperate and arctic sediments, indicating a mesophile-dominated community. Results reveal adaptation of N_2-producing microbial communities to *in situ* temperatures.

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