(Meta)genome enabled insights into chemolithoautotrophy at deep-sea hydrothermal vents

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It is well established that microrganisms mediate the transfer of geothermal energy to higher trophic levels at deep-sea hydrothermal vents. To better understand the underlying processes and the organisms catalyzing them, we are pursuing a metagenomic approach. Specifically, we are interested in identifying the pathways utilized for energy generation and autotrophic carbon fixation. Fluids from two diffuse flow vent sites that differed in physicochemical conditions were sampled at 9°N on the East Pacific Rise. DNA was extracted and subjected to 454 pyrosequencing. The analyses show that oxidation of reduced sulfur compounds coupled to either oxygen or nitrate reduction, are the predominant pathways for energy generation in these environments. These reactions are being carried out by epsilonproteobacteria, in particular members of the genera *Sulfurimonas* and *Sulfurovum*, that use the Sox- pathway for sulfur oxidation and the reductive TCA cycle for carbon fixation (Sievert *et al* [1], Nakagawa *et al*. [2]). However, there are also distinct differences between the two metagenomes at both sites that can be attributed to the differences in physicochemical conditions. Analyses are currently being carried out to reconstruct the overall metabolic potential of the communities at both sites, which will be contrasted to information available from other reducing habitats, such as cold seeps and whale falls. By combining the metagenomic analyses with analytical chemistry, isotopic analysis, and microbiological methods, we aim at a comprehensive assessment of chemoautotrophic production at deep-sea vents.

[1] Sievert *et al* (2008) *Appl Environ Microbiol* **74**, 1145-1156
[2] Nakagawa *et al*. (2007) *Proc Natl Acad Sci* **29**, 12146-12150

Polar twins: The Antarctic and North Pacific during ice ages

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In the 1990's, the Antarctic "stratification" hypothesis was born as an explanation for reduced atmospheric carbon dioxide levels during ice ages. According to this hypothesis, reduced ventilation of the ocean interior through the Antarctic surface prevented release of deeply sequestered excess carbon dioxide. The glacial Antarctic stratification hypothesis was counterintuitive to those working on anthropogenic global warming, as models predicted stabilization of the polar ocean with anthropogenic warming, in the opposite sense of this hypothesis. However, there is now evidence that ongoing southern westerly wind changes are driving increased overturning and venting of biologically sequestered CO_2 out of the deep ocean, a warming-associated change that is at least superficially consistent with the paleoceanographic evidence for greater Antarctic ventilation of the interior under warmer climates. Still, it remains unknown whether the reconstructed increase in Antarctic overturning at the end of ice ages has the same physical mechanism as the ongoing Southern Ocean changes.

We describe paleoceanographic data, both previously published and new, from the subarctic North Pacific. These data suggest that this region has undergone glacial cycles in upper water column stratification that are similar to those of the Antarctic, with stronger stratification (less nutrient supply from the subsurface to the euphotic zone) during ice ages. In apparent contradiction to this interpretation of ice age conditions, models have predicted that the North Pacific will become more strongly stratified under anthropogenic warming. The situation is analogous to the relationship of paleoceanographic and ocean model findings for the Southern Ocean before the recent observations of increased CO_2 release from that region. Thus, it begs the question of whether, in the near future, the North Pacific will also show behavior that violates the model-based prediction of increased stratification under global warming. At the same time, that both the Southern Ocean and the subarctic North Pacific stratify during ice ages would seem to provide a strong constraint on the physical cause of this stratification. The proposed mechanisms for ice age Antarctic stratification will be evaluated with respect to their ability to explain ice age stratification in the North Pacific as well, and implications for anthropogenic warming will be considered.