2018 Geodynamics Seminar

# Reconstructing the Evolutionary Self-organization of the Oceanic Biogeochemical Cycles


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**1:30 – 2:30pm**
**Clark Lab 507, Quissett Campus, WHOI**


**Abstract**

Metabolism is the biochemical network that provides the building blocks and energy for all cells on Earth. The collective metabolic activity of all cells in turn mediates the global biogeochemical cycles, which regulate Earth's climate. Metabolism thus provides a powerful lens for linking the evolution of cells to the self-organization of the biosphere. I will discuss these ideas in the context of the abundant phytoplankter *Prochlorococcus* and co-occurring heterotrophs. Using this system, I will argue that over geologic time evolution is not a zero-sum game, but rather promotes a more energetic, more massive and more complex biosphere. Specifically, I will discuss integrated genomic, physiological and ecological evidence that evolution of oceanic microbial cells steadily increased their metabolic rate, thereby drawing down environmental nutrient levels and increasing total ecosystem biomass. The organic waste byproducts of this process in turn promotes mutualistic self-amplifying feedback loops among species that reinforce this drive at the ecosystem level, and which moreover resemble the metabolic interdependencies of organelles within plant cells. I will then argue that the evolutionary self-organization of oceanic ecosystems helped life push through key negative feedbacks within Earth oxygenation, and more generally that the latter reflects an increasing biospheric energy flux. Against this backdrop, I will end by discussing recent metabolomic and single-cell genomic analyses that suggest a link between the cellular regulation of *Prochlorococcus* and the global niche partitioning of sympatric heterotrophs. These results highlight the importance of looking across all levels of organization in understanding the co-evolution of oceanic microbes and the biogeochemical cycles they mediate.


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