# Field evidence, modeling results, and new investigative strategies shed light on the timing and amplitude of sea level change during past interglacials

M.E. RAYMO[1], A. ROVERE[1], J.X. MITROVICA[2], M. O'LEARY[3], P. HEARTY[4] AND J. INGLIS[5]

[1]Lamont-Doherty Earth Observatory of Columbia University, raymo@ldeo.columbia.edu
[1]Lamont-Doherty Earth Observatory of Columbia University, rovere@ldeo.columbia.edu
[2]Harvard University, jxm@eps.harvard.edu
[3]Curtin University, Perth, mickoleary.sci@googlemail.com
[4]University of North Carolina, Wilmington, kaisdad04@gmail.com
[5]University of North Carolina, Chapel Hill, jezinglis@gmail.com

Oscillations of sea level, whether rapid or gradual, influence the degree and style of shorline formation including reef framework construction, destruction, and preservation. Using insight from modern shoreline systems, members of the PLIOMAX project have mapped mid-Pliocene, MIS11, and MIS5e shorelines at numerous localities around the world and modeled the effects of subsequent glacial isostatic adjustment (GIA) on their current position. For both MIS5e and MIS11 we conclude that an ice sheet stability threshold was crossed in the last few kyr of each interglacial resulting in the catastrophic collapse of polar ice sheets with a rise in eustatic sea level to ~9m or more above present. We further show that dynamic topography, supported by convectively maintained stresses generated by viscous flow in the mantle and associated buoyancy variations in the lithosphere, plays a significant role in the post-depositional displacement of Pliocene and even much younger Pleistocene shorelines. We will discuss how we are using predicted global patterns of GIA and dynamic topography to guide field efforts aimed at extracting the eustatic component of sea level change during past warm climates. We also discuss how our field data is helping, in turn, to constrain uncertainties in models of both GIA and the long-term convective evolution of the Earth (uncertainties in mantle viscosity, for instance).

# Giving microbial communities a solar supercharge: does the transition to photosynthesis in extreme environments drive taxonomic, biochemical, and metabolic novelty?

JASON RAYMOND, ERIC ALSOP AND MATTHEW KELLOM

School of Earth & Space Exploration, Arizona State Uni.

A combination of prolific biological diversity and steep physical and geochemical gradients make hydrothermal ecosystems outstanding environments for understanding the dynamic interplay between life and environment. Our work investigates taxonomic (e.g. 16S rRNA), metagenomic, and transcriptomic profiling of microbial communities in extreme environments. One such study focuses on communities occurring along a 40+ degree C temperature gradient in a geochemically well-characterized alkaline hot spring in Yellowstone National Park (YNP). The communities along this single outflow channel show changes in community organization, metabolism, and (taxonomic) biodiversity that can be directly related to changes in the geochemistry of their aqueous environments.

One unexpected result of this work comes at the so-called photosynthetic fringe, where "hot" chemotrophic metabolism gives way to "cool" phototrophy. This transition occurs between 55 and 73 degrees C in alkaline YNP springs—an apparent upper temperature limit on photosynthesis that is still poorly understood. While in general, biodiversity increases as temperature decreases, 16S analysis reveals that community diversity—quite unexpectedly—peaks not below but rather just above the onset of photosynthesis, tapering off at both higher and lower temperatures. This increase in biodiversity is not simply the union of lower T photosynthetic and higher T chemotrophic communities; intringuingly, new species not observed in any other communities occur only at this intersection.

We are integrating molecular genetic data with geochemical analyses to investigate several plausible hypotheses for this boost in diversity. Furthermore, this integrated approach provides unprecedented resolution of how the onset of photosynthesis in complex, natural communities results in a dramatic shift not only in the overall numbers but also in the distinct types of biomolecules able to be synthesized by the community at large. Whereas taxonomic diversity is at a maximum above the photosynthetic fringe, biochemical and metabolic diversity is highest below the fringe, where the energetic supercharge provided by photosynthesis makes accessible new and otherwise costly metabolic capabilities.

Finally, we hypothesize that the transitions associated with the photosynthetic supercharge may provide important insights into how the invention of photosynthesis (oxygenic photosynthesis in particular) provided the molecular underpinnings for early life on Earth to achieve new levels of complexity and stands as the single most important biological innovation since the origin of life itself.


DOI:10.1180/minmag.2013.077.5.18