ARCHAEAL ECOLOGY IN THE SHADOW ZONES S.A. Lincoln[1] and R.E. Summons[1], Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02141, USA slincoln@mit.edu

Modern oxygen minimum zones – "shadow zones" - can serve as useful analogs for periods of widespread oceanic anoxia that have affected life throughout Earth history. The geologic record is punctuated by black shales that provide evidence for multiple episodes of anoxia, and these shales offer geochemical and paleontological clues about the duration, severity, and sustaining mechanisms of anoxia in the past.

Oxygen minimum zones (OMZs; dissolved oxygen < 22 μM) are sites of globally important biogeochemical processes. Although they represent less than one percent of ocean volume today, they account for as much as one half of marine denitrification and are significant sources of the greenhouse gases carbon dioxide and nitrous oxide. Microbes mediate these processes, but microbial ecology and community structure in OMZs are not well understood. In particular, information about the roles of marine archaea in these environments is lacking. Here, we approach this question by determining correlations between abundances of archaeal membrane lipids in OMZ particulate organic matter and factors including depth, salinity, in situ temperatures, and concentrations of oxygen, nitrate, nitrite, ammonia and phosphate. The strong redox gradients of OMZs give rise to sharp biogeographic boundaries, making these sites valuable for assessing the influence of population composition on the pool of archaeal lipids.

We report abundances of glycerol dialkyl glycerol tetraether (GDGT) lipids from depth profiles of particulate organic matter from OMZs in the eastern South Pacific (20S, 70W; sampled from 0-800 m), the Gulf of California (27N, 111W; sampled from 3-400 m) and the eastern tropical North Pacific (10N, 104W; sampled from 3-1000 m). The oxygen minima in these sites differ; the shallow eastern South Pacific OMZ (~75-300 m) is driven by intense upwelling-fueled biological productivity, while the deeper (~350-650 m) eastern tropical North Pacific OMZ is viewed as representative of oxygen minima in open-ocean sites with productive waters underlain by poorly ventilated intermediate waters [1]. A more complex interplay of physical oceanographic phenomena is thought to be responsible for maintaining the OMZ in the Gulf of California ([2]; ~400-700 m when sampled).

Water column GDGTs may comprise both a core or fossil component and a living, intact polar lipid (IPL) component in which labile polar headgroups remain intact [3]. Previous OMZ studies [4] have focused on the core lipid component. Because upwelling has been hypothesized to carry core GDGTs from depth [5], we have analyzed both IPLs and core lipids from a subset of samples to determine whether the two components of the lipid pool contain different GDGTs and whether differences are more pronounced in sites of strong upwelling.

By developing a better understanding of the microbial processes underlying, driving and sustaining oceanic anoxia we hope to gain insight into both the ecological turning points of the past and those we observe today as climate change increases the extent and impact of shadow zones in today's oceans.

References:

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