

## MARINE ARCHAEA LIPIDS: PATTERNS AND PROVENANCE IN THE WATER-COLUMN

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We measured archaeal lipids from globally distributed samples of freshwater, marine, and hypersaline suspended particulate matter. Cluster analysis of relative lipid distributions identified four environmentally distinct groups, including: 1) marine epipelagic waters, 2) marine mesopelagic/upwelling waters, 3) freshwater/estuarine waters, and 4) hypersaline waters. There is a distinct near-absence of ring-containing glycerol dialkyl glycerol tetraethers (GDGTs) at high salinity. Different archaeal communities populate marine (mesophilic Crenarchaeota and Euryarchaeota), and hypersaline environments (halophilic Euryarchaeota) and community shifts must regulate differences in lipid patterns between marine and hypersaline waters. We propose that community changes within mesophilic marine Archaea also regulate the lipid patterns distinguishing epipelagic and mesopelagic/upwelling zones. Changes in the relative amounts of crenarchaeol and caldarchaeol and low relative abundances of ringed structures in surface waters differentiate lipids from the epipelagic and mesopelagic/upwelling waters. Patterns of lipids in mesopelagic (and upwelling) waters are similar to those expected of the nitrifying Group I Crenarchaeota, with predominance of crenarchaeol and abundant cyclic GDGTs; non-metric multidimensional analysis (NMDS) shows this pattern is associated with high nitrate concentrations (likely tracking nitrite). In contrast, limited culture evidence indicates marine Group II Euryarchaeota produce mainly caldarchaeol and some, but not all, of the ringed GDGTs and we suggest that these organisms contribute significantly to lipids in epipelagic marine waters.

Calculated TEX<sub>86</sub> temperatures from particles in sediment traps in the northeastern Pacific and Arabian Sea are well-correlated to annual sea surface temperature, indicating that the TEX<sub>86</sub> signal reaching sediments is derived primarily from the surface waters (Wuchter et al. 2006). However, Calculated TEX<sub>86</sub> temperatures in mesopelagic samples (reported here and in Wuchter et al. 2004) are always much warmer than measured *in situ* temperatures. Furthermore, the residual temperature (calculated TEX<sub>86</sub> temperature-in situ temperature)

correlates with nitrate concentrations (Figure 1). Our cluster analysis, ordination, TEX<sub>86</sub> results all suggest observed values of TEX<sub>86</sub> are subject to changes in archaeal ecology as influenced by nutrient fluctuations or other perturbations which in turn can affect both surface water GDGT production and GDGT preservation and transport such as zooplankton grazing. Therefore, in ancient applications, reported extreme temperatures shifts (e.g. Zachos et al. 2006; Dumitrescu et al. 2006) may indicate the TEX<sub>86</sub> lipids are not recording temperature alone, but equally interesting changes in nutrient concentrations, oceanographic conditions, and ecology.

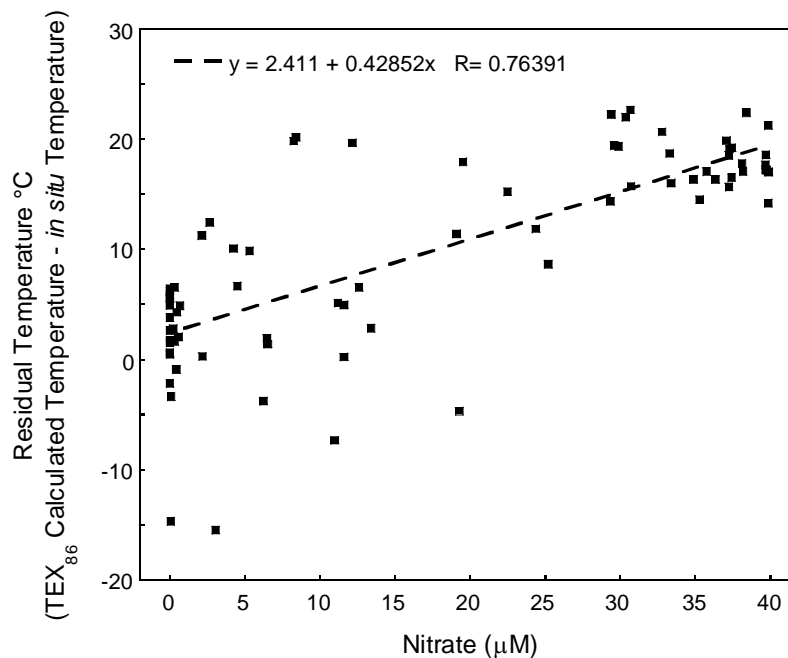


Figure 1. Temperature residuals (Calculated TEX<sub>86</sub> temperatures – *in situ* temperature) from this study and from Wuchter et al. (2005) plotted against nitrate. Sites include the Arabian Sea, the Equatorial Pacific, and the Bermuda Time Series site and the Bermuda-Atlantic Time Series site.

## REFERENCES

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