Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.4775

Archaeal niche partitioning and non-temperature effects on the TEX_{86} paleotemperature proxy in planktonic communities from the Gulf of Mexico

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Membrane lipids of planktonic archaea, glycerol diphytanyl diethers (archaeols) and glycerol dibiphytanyl glycerol tetraethers (GDGTs), are preserved in ocean sediments over geologic timescales and can be used to reconstruct ecological and environmental conditions. The temperature-dependent distribution of GDGTs found in cultivated Marine Group I Thaumarchaeota forms the basis of the widely used TEX_{86} paleotemperature proxy. However, multiple additional clades of archaea are abundant in the ocean, such as the uncultivated Marine Group II Euryarchaeota, and a diverse array of thaumarchaeal subgroups distantly related to cultivated Thaumarchaeota. The lipid compositions of these groups, the environmental parameters influencing those lipid compositions, and their potential contributions to the GDGT pool and thus the TEX_{86} signal, remain poorly constrained. Here, we used combined lipidome and 16S rRNA profiling to evaluate the lipid compositions of planktonic archaeal communities and their relationship to the physical and chemical zonation of the water column in the oligotrophic northern Gulf of Mexico and the anoxic brine of the Orca Basin at the seafloor of our study site. We find that lipid abundances and archaeal community composition follow well defined chemical and physical gradients in the water column. Almost the entire quantity of GDGTs in the water column is found in zones dominated by Thaumarchaeota at or below the base of the photic zone. GDGT concentrations and thaumarchaeal respiratory activity peak in two narrow zones in the water column, the deep chlorophyll maximum and the chemocline above the brine pool, which harbor distinct thaumarchaeal communities and GDGT compositions. These zones of high thaumarchaeal activity show cold-biased TEX_{86} values that are uncoupled from *in situ* temperature. These results suggest that thaumarchaeal community composition and activity control GDGT composition and TEX_{86} in the water column and possibly in the geologic record. Distinct associations of archaeols with Marine Group II Euryarchaeota and Woesearchaeota inhabiting the uppermost photic zone and the brine, respectively, suggest that these groups do not significantly contribute to the oceanic GDGT pool but may leave distinct molecular fingerprints.