Factors controlling the ^{13}C contents of archaeal GDGTs in the water column and sediments

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Archaeal glycerol dibiphytanyl glycerol tetraether (GDGT) lipids are preserved in sediments and sedimentary rocks on million-year timescales. Planktonic, ammonia-oxidizing Thaumarchaeota are believed to be the major marine sources of these GDGTs, implying that most production and export should be localized to 80-250 m in the water column in association with the depth of greatest ammonia oxidation and the subsurface NO_2^- maximum. Calculations of abundance-weighted export fluxes support this idea.

To examine the relationships between production and export of GDGTs, as well as the potential for additional benthic sources to sediments, we measured $\delta^{13}C$ values of GDGTs in (*i*) suspended particulate matter (SPM) of the western South Atlantic Ocean, (*ii*) a variety of available sediment core-tops, (*iii*) a sedimentary paleorecord, and (*iv*) a modern hydrocarbon seep environment.

Thaumarchaeota are believed to fix most or all of their carbon directly from dissolved inorganic carbon (DIC) [1, 2]. However, nearly all GDGT $\delta^{13}C$ values are more ^{13}C-depleted than would be predicted based solely on autotrophic assimilation. Values consistent with pure autotrophy occur only in GDGTs from core tops > 1000 m water depth or in SPM from > 300 m in the water column. Most other values, including all SPM values from the NO_2^--maximum (*i.e.,* the source of most GDGTs) are 1-4‰ depleted in ^{13}C relative to expectations. This indicates that the average carbon metabolism of the planktonic archaeal community either is mixotrophic (≥ 25% organic carbon assimilation) or that the published ε value [3] for the model organism *N. maritimus* does not represent the total autotrophic community. Finally, while individual GDGTs within SPM samples have identical $\delta^{13}C$ values, in sediments, the isotopic composition of individual GDGTs varies. In extreme cases, values < -90‰ are seen in seep environments.

[1] Könneke et al., (2005) *Nature* **437**, 543–546. [2] Kim et al., (2016) *PNAS* **113**, 7888-7893. [3] Könneke et al., (2012) *Org Geochem* **48**, 21-24.