Calibrating geostable lipid profiles to archaeal bioenergetic state

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Biomarkers derived from membrane lipids can be stable on geologic timescales, making them attractive targets for paleo-environmental reconstructions. One such paleotemperature proxy (TEX_{86}) is based on the degree of cyclization in 86-carbon isoprenoid membrane lipids — glycerol dialkyl glycerol tetraethers (GDGTs) — which are the main membrane lipids in cosmopolitan marine thaumarchaeota and thermoacidophilic crenarchaeota. Archaeal lipid proxies are based on the notion that microorganisms optimize membrane fluidity and permeability in response to environmental factors such as temperature, by altering the number of cyclopentyl and cyclohexyl rings in core isoprenoid lipids [1]. However, there is mounting evidence that these archaea adjust their membrane GDGT composition in response to fundamental constraints, e.g. metabolic efficiency and substrate availability [2, 3, 4, 5].

In this study we tested the hypothesis that GDGT distributions will vary in response to electron donor/acceptor availability, and ultimately, free energy. We cultured the model thermoacidophile *Acidianus* spp. DS80 isothermally in batch, where predicted bioenergetics varied widely with the redox couple provided. Upcoming experiments will explore lipid profiles under anaerobic/aerobic and heterotrophic/autotrophic growth in chemostat (i.e. constant rate, isothermal, constant pH). We discuss results and their implications for interpretation of environmental GDGTs.

[1] De Rosa et al., (1980) Phytochemistry 19, 827-831. [2] Qin et al., (2015) PNAS 112, 10979-10984. [3] Hurley et al., (2016) PNAS 113, 7762-7767. [4] Elling et al., (2015) GCA 238-255. [5] Amenabar et al., (2017) Nature Geoscience.