The importance of non-phosphorous containing lipids in thermophilic archaea and bacteria inhabiting terrestrial hot springs

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Extremophiles synthesize unique membrane lipids that have conceivably enabled their diversification into new ecological niches. For example, the presence of isoprenoidal glycerol dialkyl glycerol tetraether lipids (GDGTs) results in archaeal cell membranes with lower ion permability when compared to fatty acid containing bacterial lipids [1]. In this study, we investigated the intact polar lipid composition and microbial diversity of archaea and bacteria using 16S rDNA IonTorrent sequencing in Yellowstone National Park geothermal communities spanning gradients in temperature from 28 to 84°C and pH 1.8 to 8.7. In total, 16 environmental parameters were considered from these 20 sites in order to elucidate relationships between geochemical, community, and membrane lipid structural variation.

Archaeal glycolipids were abundant in hot springs with elevated temperature, high conductivity, and high metal ion content. These glycolipids comprised GDGT and H-shaped GDGT core structures with up to 3 sugars and additional methylations in the biphytane chain [2]. Intact polar lipids attributable to bacteria included mainly glycolipids and aminolipids with either diester, diether, or mixed ester/ether core structures. Notably, in most hot springs archaeal and bacterial phospholipids comprised less than 10% of the total lipid composition. Shifts from phospholipids to glyco- or aminolipids with increasing temperature have been reported previously in pure cultures [3,4]. Based on the observed distribution patterns along geochemical gradients, we discuss potential physiological roles of the dominant lipid structures and how they may have played a role in the diversification of microbial populations into new geochemical realms.

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