The source and fate of intact polar lipids in the hydrothermally altered sediments of the Cathedral Hill vent system, Gulf of California, USA

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Intact polar lipids (IPLs) are frequently used as biomarkers for living microorganisms in sedimentary environments. Therefore, these compounds can potentially be used to track the habitable range or thermal limits of the subsurface biosphere. Upon senescence of a cell, IPLs quickly lose their polar head groups, leaving thermally more stable core lipids (CLs) that can become further degraded and bound into the sedimentary organic matter. For this study, we are evaluating the source and fate of IPLs and CLs within the pyrolytic conditions naturally present at Cathedral Hill, a sedimented hydrothermal vent system, in Guaymas Basin, Gulf of California. Here, in situ petroleum formation may be occurring as organic-rich sediments are exposed to high temperature conditions that are projected to reach up to 155°C within 21 cm sediment depth. This study is tracking the distribution of IPLs and CLs to (1) assess the microbial community that inhabits these sediments at a chemotaxonomic level, (2) determine the thermochemical stability of these lipids, and (3) track the degradation pathways that may result from their pyrolytic conversion into hydrocarbons. Thus far, we have identified and quantified bacterial and archaeal IPLs and CLs in a core transect extending from the center of the vent complex to the exterior of an overlying *Beggiatoa* microbial mat. Identified compounds include archaeal IPLs and CLs, such as archaeol (AR, 1G-AR, 2G-AR, 1MeC-AR), glycerol dialkanol diethers (GDDs, OH-GDDs), and gycerol dialkyl glycerol tetraethers (1G- and 2G-GDGTs, iGDGTs, brGDGTs). Also present in the samples are multiple unknown phospholipids that are likely bacterial in origin. Some of the identified compounds have distinct stratigraphic trends. For example, 2G-GDGTs, possibly derived from methanotrophs, were extracted from sediments ranging up to ~50°C. The 1G-GDGTs, likely sourced from hyperthermophilic archaea, are observed in sediments reaching ~145°C, which sets a new record for the threshold of life. The abundance of core iGDGTs also decreases with sediment depth; however, only minor biphytanes (break-up products of GDGTs) have been found. This suggests that at high vent temperatures either more time is needed to crack the lipids into hydrocarbons, or there are microbial processes preventing breakdown.

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