Lipid preservation in hot spring silica deposits: Elucidating geothermal chemistry and ecology

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Geothermal environments and their microbial inhabitants play a key role in origin of life studies and astrobiology. Diverse and deeply-branching thermophilic and hyperthermophilic bacteria and archaea inhabit geothermal systems and their mineral deposits. Lipid biomarkers are relatively well preserved in geothermal deposits and once encased in the mineral matrix can persist for extended periods of time [1, 2]. Consequently they can be used to profile microbial diversity and function and, where preserved in ancient materials, assess past geothermal conditions [2].

We examine the lipid biomarkers preserved in silica sinters from the Taupo Volcanic Zone (TVZ), New Zealand. Analyses show bacterial biomarkers including free fatty acids, 1,2-diacylglycerophospholipids, 1,2-di-*O*-alkylglycerols, 1-*O*-alkylglycerols, monomethyl alkanes and various hopanoids. Dominant archaeal lipids include archaeol and glycerol dialkyl glycerol tetraethers (GDGTs). The structure, distribution and isotopic composition of these lipids are unusual and reflect the chemical and microbiological conditions present at the time of sinter formation. For example: archaeal lipids, specifically highly cyclized GDGTs, are predominant at high temperatures and low pH; and longer chain fatty acids are more abundant at higher temperatures. Unusually high carbon isotopic compositions (40‰ range, with some values exceeding 0‰) are also detected.

Preservation of a range of the aforementioned functionalized lipids is observed in the sinters suggesting that silicification facilitates geochemical preservation. Most compounds have been diagenetically or thermally altered; for example, free fatty acids, derived from phospholipid hydrolysis, predominate, and bacteriohopanoids have been converted into less functionalised products. The altered structures can be related to specific biological precursors and can be used in combination with their isotopic signatures to reconstruct geothermal chemistry and microbial ecology.

[1] Pancost *et al* (2006) *Geobiology* **4**, 71-92 [2] Kaur *et al* (2011) Astrobiology **11**, 3, 259-274