

Temperatures from archaeal tetraether lipid distributions: problems and progress

Stefan Schouten (Royal Netherlands Institute for Sea Research)

Proxies to estimate past sea surface temperatures (SST) are one of the main tools for paleoceanographers to gain information about past oceanographic and climatic conditions. Traditionally, these proxies mainly comprise the chemical analysis of carbonate of planktonic foraminifera, mainly oxygen isotopic compositions and Mg/Ca ratio's. While these proxies have revealed a wealth of information on past Cenozoic sea surface temperatures, in particular for the Quaternary, it is well known that SST estimates using these proxies are affected by changes in sea water chemistry such as salinity and pH and carbonate dissolution. This is in particular a problem for SST estimates stretching into the early Cenozoic where changes in sea water chemistry and proxy-temperature calibrations are difficult to constrain. An alternative SST proxy is the U^{K}_{37} ratio of long chain alkenones synthesized by haptophyte algae. Its main advantage over foraminiferal proxies is that it is firmly tied to the photic zone, is not affected by changes in sea water chemistry and relatively resilient towards diagenesis. However, occurrences of alkenones are rare in sediment older than the Quaternary and only yield scattered SST records for the early Cenozoic, also because it is not applicable >28 °C.

We have been focusing on another set of organic compounds, the so-called glycerol biphytanyl glycerol tetraether lipids or GDGTs. These compounds are synthesized by Archaea which form one of the most abundant microbes in the present day ocean. Culture studies in the early 80's of hyperthermophilic relatives already revealed a strong relation between temperature and GDGT distribution and analysis of globally distributed marine surface sediments also revealed a strong relation between temperature and GDGT distribution, in particular using the TEX_{86} ratio of GDGTs. The main niche this proxy fills in comparison to presently used proxies is that it can be applied in sediments as old as the late Jurassic including SSTs >28 °C. However, like with other SST proxies a number of constraints and uncertainties on its application have also emerged over the last years. In this talk I will review the current state of the art of the TEX_{86} temperature proxy.