TEX86 THERMOMETRY IN SINKING PARTICLES FROM THE EQUATORIAL TO THE SUBPOLAR ATLANTIC: ecological differences and non-temperature effects

Eunmi Park[1,2,*], Gerhard Fischer[1,2], Jens Hefter[1], Gesine Mollenhauer[1,2]

[1]Alfred-Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
[2]MARUM-Centre for Marine Environmental Sciences & Department of Geosciences, University of Bremen, Germany
*(eunmi.park@awi.de)

TEX_{86} is an organic proxy for sea surface temperature (SST) based on the relative abundance of Glycerol dialkyl glycerol tetraethers (GDGTs), which are mainly biosynthesized by Thaumarchaeota in the Ocean (DeLong, 2003). Despite of its being widely applied, in particular to paleoenvironmental studies of the Cenozoic, many aspects remain controversial, including the depth and seasonality of its production, the export mechanisms to deep-sea sediments, and the nonthermal ecological factors such as nutrient and oxygen levels in proxy signal (Schouten et al., 2013).

To address some of these issues, we investigated the seasonality of GDGT production and its associated TEX_{86} signal in time series samples of sinking particles collected using sediment traps from different ecological settings (coastal and equatorial upwelling, oligotrophic subtropical gyres, polar front and the high Northern latitude region) from the equatorial to the subpolar Atlantic Ocean. For most sites, the samples covered one entire seasonal cycle. The estimated temperatures based on TEX_{86} are compared with satellite SST and the water column temperatures profiles. Different TEX_{86} calibrations (TEX_{86}, TEX^{L}_{86}, TEX^{H}_{86}, 0-200 m depth integrated TEX^{H}_{86}, and Bayspar) are applied according to the site's climatic setting (Kim et al., 2010, 2012; Tierney and Tingley, 2015).

Two trap sites are located in regions under the influence of trade winds resulting in coastal (off Mauretania; Mollenhauer et al., 2015) or equatorial (northern Guinea basin) upwelling. In the Guinea basin, TEX^{H}_{86} temperatures remain lower than satellite SST throughout all seasons, and the flux-weighted TEX^{H}_{86} temperature corresponds to subsurface temperature in agreement with previous studies suggesting TEX_{86} in upwelling areas may reflect subsurface rather than surface temperatures (Lee et al., 2008; Lopes dos Santos et al., 2010). However, at the coastal upwelling site off Mauritania, the estimated temperatures show maxima similar maxima in SST, while minima in SST are not reflected accurately, and TEX_{86} based estimates are warmer. These observations suggest that TEX_{86} in sinking particles includes contributions from archaeal communities thriving in the oxygen minimum zone, where TEX86 is higher than at the surface (Basse et al., 2014). At both trap sites, TEX_{86} signals captured in the trap compare favourably with that in surface sediments. In contrast to subsurface temperature signals in other upwelling regions, at Lüderitz site off Namibia in Benguela system, TEX^{H}_{86} temperatures closely follow satellite SST between February and June.
In the oligotrophic central Brazil Basin, the TEX^{H}_{86} temperatures are 1 ~ 4 °C higher than satellite SST throughout all seasons. We propose that this may be a stress response of Thaumarchaeota in low nutrient levels, resulting in increased GDGTs cyclization and elevated TEX_{86} values (Hurley et al., 2016). At the southern Polar Front site, TEX^{L}_{86} temperatures do not follow the seasonal changes, but the flux-weighted TEX^{L}_{86} temperature is similar to SST in spring, while in the eastern Fram Strait of the high latitude North

Atlantic, the TEX^{L}_{86} temperatures are similar to satellite SST. The flux weighted TEX^{L}_{86} temperature corresponds to subsurface temperatures in spring or SST in summer and very similar TEX_{86} values are found in near-by core-top sediments. Data from the subpolar region near Iceland, where the flux weighted TEX_{86} temperature is similar to that in surface sediments and has been suggested to reflect the average temperature in 0-200 m water depth (Rodrigo-Gámiz et al., 2015).

Our data clearly illustrate the ecological diversity of the GDGT producing Thaumarchaeotal communities, which dwell in different water depths in different ecological settings. Non-temperature signals, potentially including stress response in limiting conditions, may in some regions contribute to the TEX_{86} signal exported to depth. Moreover, our observations highlight that the aggregation process leading to export of GDGTs to deep-sea sediments, which again is variable under different ecological and oceanographic conditions, additionally controls the composition of the exported GDGT assemblage. In light of our results, paleoenvironmental records of TEX_{86}-based SST estimates have to be considered to include non-temperature signals, adding further variance to the records.

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