European Association of Organic Geochemists

INFLUENCE OF DISSOLVED OXYGEN RATHER THAN TEMPERATURE ON TEX_{86}: EVIDENCE FROM AN AN OLIGOTROPHIC LAKE

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Glycerol dialkyl glycerol tetraethers (GDGTs) have shown significant promise as proxies of various climatic and environmental parameters. They are found ubiquitously in the environment and according to their stractures can be grouped into isoprenoid (isoGDGTs) and branched GDGTs (brGDGTs). In mesophilic environments, the isoGDGTs are produced by Archaea of the phylum Thaumarchaeota and Euryarchaeota, or from methanogenic and methanotrophic sources. They are found typically in aquatic settings, but also in soils, peats and dust. Water temperature appears to be the primary control on the sedimentary distributions of GDGTs. This finding led to the development of isoGDGT-derived proxies, such as TEX_{86}, which has been applied for reconstructing sea surface temperature (SST) and lake surface temperature (LST). In continental settings, the application of TEX_{86} is argued to be constrained to large lakes on the basis that Crenarchaeota in small lakes are not present in sufficient abundance to produce detectable amounts of isoGDGTs. In addition, inputs of allochthonous organic matter containing isoGDGTs to lakes may potentially hamper the straightforward application of TEX_{86}. Despite the evidence that water temperature is the primary driver of TEX_{86} in sediments, there is still a debate on the influece of other environmental variables, like dissolved oxygen (DO), and whether it might bias significantly the estimated temperatures in paleoenvironmental reconstructions.

To appraise the application of GDGTs as paleoclimate proxies in small lakes we investigated the effect of seasonal variability in temperature and dissolved oxygen (DO) on the GDGT contents in the water column of an oligotrophic karst lake in the Catalan pre-Pyrenees (Lake Montcortés). From October 2013 to November 2014, on a monthly basis, we collected suspended particulate matter (SPM) at three depths, and retrieved the particulate matter from a trap located 20 m below the lake surface, and 2 m above the lake bottom. The GDGT contents in the SPM presented a marked seasonal variation, showing the highest values in summer and autumn. However, the ratios of brGDGTs displayed no significant seasonal trend. We propose that this lack of seasonal variability indicates that the brGDGTs in lake Montcortés are derived chiefly from catchment soils, and discard any significant in situ water column inputs. In contrast, the isoGDGT proxy TEX_{86} in SPM showed a marked seasonal variability which matched the temperatures of the upper water column, and fitted well the published global lake calibration regression between TEX_{86} and mean annual LST. However, in the hypolimnion, which was seasonally depleted in oxygen in lake Montcortés, we found a relationship between TEX_{86} and DO, rather than water temperature. This finding confirms, with field data, a previous claim derived from culture experiments, that the sedimentary TEX_{86} LST signal may be confounded by DO. Consequently, the application of TEX_{86} to estimate LST may be best avoided in environments with depleted DO conditions.