APPLICATION OF ORGANIC PROXIES FOR CLIMATIC RECONSTRUCTION IN A STALAGMITE FROM MAWMLUH CAVE IN NORTHEASTERN INDIA

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Introduction

The Mawmluh cave (MC) in NE India is strongly affected by the Indian Summer Monsoon (ISM). The seasonal heavy rainfall extends from June to September, and plays a vital role for the local community that is mainly dependent on agriculture. Understanding the driving forces for ISM fluctuations within the core monsoon zone on land has become the focus of many recent paleoclimate studies. Here, we investigated a stalagmite (KM-1) retrieved from MC located in the Khasi Hills to reconstruct the climate variability covering the last glacial-interglacial transition. Therefore, we traced distribution of glycerol dialkyl glycerol tetraethers (GDGTs), which relate to change in temperature, in the KM-1 stalagmite, and used a combination of GDGT based tempearture proxies and C and O isotopes to reconstruct the past climatic conditions extending from the Last Glacial Maximum to mid-Holocene (22 to 6 ka).

Results

It has been suggested that GDGT distribution in speleothems would be derived mainly from *in situ* production rather than transfer from associated soils (Blyth et al. 2016), this is indeed what we observe form our data. We observed higher BIT (Hopmans et al. 2004) values at 22 ka that decrease during the Holocene. This change in BIT is mainly due to a strong increase in crenarchaeol along the record suggesting an increase in GDGT *in situ* production (Blyth et al. 2016). While such *in situ* production may be an issue in other more isolated stalagmites, the climatic conditions within the Mawmluh cave vary coupled with general climatic patterns due to its internal circulation, thus providing a good record of changes in the study area.

The TEX_{86}-derived temperature roughly follows the glaciation-deglaciation transition and Holocene changes (Fig. 1). The MBT index (and derived temperatures) are however negatively correlated (R^2= -0.46) to the TEX_{86} index (and derived temperature) suggesting that their vaiablity is not ruled by the same climatic factor (Fig. 1).

The $\delta^{18}O$ shows a sharp depletion of ~9‰ at the Younger Dryas transition between 12.1 ka and 11.1 ka (Fig. 1). This short-lived deglaciation after 18 ka was punctuated by the cold Heinrich event at 17 ka. The low $\delta^{18}O$ values at 15 and 13.5 ka, refers to increased monsoon around Bølling-Allerød (Fig. 1). The warm and wet early Holocene period indicated $\delta^{18}O$ value from -0.18‰ at 12.1 to -6.82 at 11.1 ka. The $\delta^{13}C$ record for KM-1 ranges from 1.95‰ at 19.9 ka to -6.61‰ at 9.07 ka. The $\delta^{13}C$ data reveals that the vegetation density might have increased enormously with advent of the Holocene warming where it records ~ -4‰ shift.

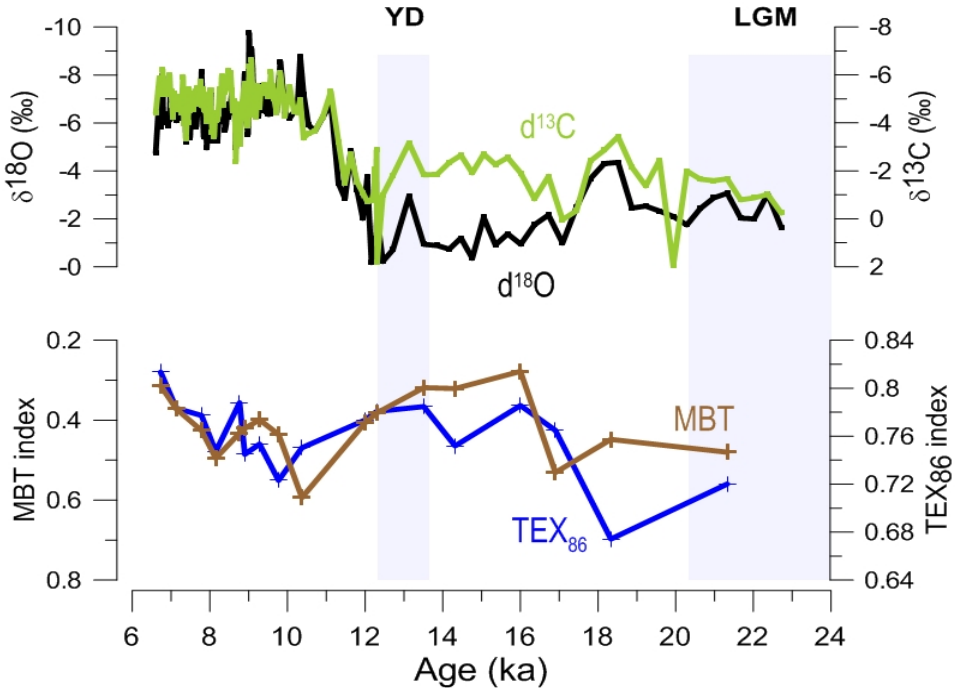

***Figure 1**. Variability of carbon and oxygen isotope, GDGT-derived temperature indices, in stalagmite KM-1, Mawmluh cave, India. Note the inverse y-axis for the MBT-index. Approximate time of Younger Dryas (YD) and Last Glacial Maximum (LGM) are indicated.*

Conclusions

For the first time, molecular data derived from archaeal and bacterial membrane lipids were coupled to stable isotope records ($\delta^{13}C$ and $\delta^{18}O$) and compared to other speleothem records in Asia to trace the important climatic changes associated with ISM variability and intensity, and its impact on landscape. The origin of these organic compounds seems to be *in situ* microbial communites within the cave, but some input from the overlying soil zone is not ruled out. A clear shift is observed at the Pleistocene – Holocene transition with strong increase in iso-GDTGs over br-GDGTs indicating an increase in *in situ* production.

The TEX_{86} shows a good correspondence with $\delta^{18}O$ records for temperature, thus highlighting the potential for using GDGTs in speleothems to interpret paleotemperature variability.In contrast, the MBT'-CBT proxy is anti-correlated to the global and TEX_{86}-derived temperatures. However, this proxy shows some coupling to monsoon strength and wetness. Overall, our results highlight the potential of these organic proxies for paleoclimate reconstruction to be applied in speleothems opening a whole new field for continental climatic reconstruction.

References

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