THERMAL DIAGENETIC IMPACT ON GDGTs IN LABORATORY SIMULATION: IMPLICATIONS FOR APPLICATION GDGT-BASED PROXIES IN DEEP TIME

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Introduction

Glycerol dialkyl glycerol tetraethers (GDGTs) are widely used in paleoclimate reconstruction, however their degradation process is not well understood. The different thermal stabilities among GDGTs could lead to bias of related proxies, which significantly affect the applications of GDGT-related proxies in deep time. Diagenetic simulation is a useful way to tracking diagenesis of organic matters and thus was used to simulate GDGTs degradation process (Schouten et al., 2004). However, only isoprenoid GDGTs (iGDGTs) were considered in previous study. This study could provide the guidance for the potential bias of proxies caused by GDGT degradation. Also, the high proportion of bound GDGTs released by simulation is discussed.

Experimental

In this study, a soil sample (36°33'2.58"N,100°43'37.32"E) was subjected to diagenetic simulation experiment along a thermal gradient (150, 200, 250, 300 °C). A pressure vessel was filled with 10 g soil sample, c.a.10 ml ultrapure water and argon gas to exclude remaining oxygen. It was put into a furnace whose temperature increased at a rate of 100 °C/h to the targeted temperatures and then kept for 72 hours at each temperature. A duplicate sample was set to improve reliability. The equivalent Ro was calculated by a software “Kinetics”.

Results

The initial total concentration of GDGTs is 0.4 μg/g dry soil. After the heating experiment, the concentration increases to 3.17 ± 0.02 μg/g soil (150°C) and 5.06 ± 0.39 μg/g soil (200°C). The total GDGT concentration increases by 1161% at 200°C, probably because some GDGTs incorporated into macromolecule such as humus and intact polar lipids were released as core lipids after heating, so the increased part of major GDGTs detected at 200°C were the bound lipids. iGDGTs are more prone to be bound into macromolecule than branched GDGTs (bGDGTs) since the ratio of iGDGTs to bGDGTs is higher at 200°C (5.68) than the original sample (1.68), while other proxies are relatively constant between free and bound pool.

However, at 250°C and 300°C, the concentration of GDGTs drastically decreases to 0.09 ± 0.01 μg/g dry soil (300 °C), indicating that both the original and released GDGTs were degraded. The ratio of degradation products glycerol dialkanol diethers (GDDs) to GDGTs increase from 0.08 (original sample) to 0.77 ± 0.07 (300°C), indicating that at least a small proportion GDGTs were degraded to GDDs. At Ro = 0.71 (300°C), although 23% of original GDGTs were still preserved, the distribution of GDGTs changed, leading to the bias of related proxies: MBT decreases from 0.14 to 0.09, and TEX86 increases slightly. Generally,
iGDGTs are more resistant to degradation than bGDGTs. Crenarchaeol regioisomer is the most recalcitrant, and more methyl groups in bGDGTs are better preserved.

Conclusions

During the diagenetic process, the bound GDGTs could be released and with increased thermal maturity, both the free and bound GDGTs are degraded. This leads to the bias of some related proxies.

References