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In situ production of branched glycerol dialkyl glycerol tetraethers during Mediterranean sapropel formation

UNYIME U. UMOH, XIAOXIAO ZHAO AND DR. FELIX J. ELLING

Christian-Albrechts-Universität zu Kiel

Mediterranean sapropels constitute intervals of past water column anoxia that resulted in elevated organic carbon burial, which are contrasted by low-organic carbon sedimentation from an oxygenated water column preceding and succeeding sapropel deposition. These intervals are ideal to study the use of novel biomarker proxies to trace anoxic conditions. This study investigates the deposition of branched glycerol dialkyl glycerol tetraethers (GDGTs) and their derivatives in sapropels deposited in the Ionian and Levantine seas during the Pliocene and Pleistocene. In modern anoxic basins, abundance of branched GDGTs has been interpreted to originate from unidentified planktonic microorganisms favoring anoxic conditions (e.g., [1]). Sediment cores spanning four sapropel events S4 (onset: 108 ka before present), S5 (128 ka), S7 (197 ka) and S74 (3.004 Ma) from two Eastern Mediterranean locations, Ocean Drilling Program Leg 160 sites 964 (36.26° N; 17.75° E; 3658 m water depth) and 967 (34.07° N; 32.73° E; 2553 m water depth) were used for this study. In the sapropel samples, enhanced abundances of the overly- and sparsely branched GDGTs (OB- and SB-GDGTs, respectively), hybrid isoprenoid/branched GDGTs, branched glycerol monoalkyl glycerol tetraethers, regularly detected branched GDGTs (B-GDGTs) indicate their preferential production under anoxic conditions. The elevated concentrations of OB-GDGTs, IB-GDGTs, and SB-GDGTs point to abundant unknown, likely planktonic, bacteria with higher concentrations in the Levantine Sea possibly signaling enhanced productivity. The abundance of OB-GDGTs, IB-GDGTs, and SB-GDGTs during sapropels suggests that these compounds can potentially track anoxia through geological time. Methylation Index $MI_{(OB/B/SB)}$ values were elevated in the sapropels and similar to the modern Black Sea and Cariaco Basins, likely indicating lipid adaptation by the source organisms to anoxic conditions or a specific anoxic microbial community. Altogether, this study adds to the growing data of diverse GDGT assemblages associated with organic carbon burial and the complex microbial community structure during periods of marine anoxia.

[1] Liu, X.-L., Zhu, C., Wakeham, S. G., and Hinrichs, K.-U. (2014), In situ production of branched glycerol dialkyl glycerol tetraethers in anoxic marine water columns, Mar. Chem., 166, 1–8.