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The origin of unusual Pliocene sapropel and diatomite layers: A case study for future climate projections

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Distinctive organic-rich sapropel layers found in the Eastern Mediterranean are associated with stratification-linked reduction in ventilation and enhanced primary productivity resulting from freshwater outflow during precession minima (Rossignol-Strick, 1983; Rohling and Hilgen, 2007). These layers can therefore provide insight into the consequences of periods of reduced oxygen contents which are predicted for future oceans under global warming.

Along the south coast of Sicily, over four kilometres of exposed marine Pliocene sediments can be found as continuous cliff outcrops which cover the lower part of the Pliocene "Trubi" formation (Brolsma, 1978). These sediments show a quadripartite cycle of white limestone, grey marl, white limestone, beige marl (Brolsma, 1978). The grey marl sapropel layers are characterized by enhanced organic carbon content, lower $d^{18}O$ of planktic foraminifera, and low Ti/Al, which coincide with with a minimum in the precession index, whereby perihelion occurs in the N. Hemisphere summer; the beige marl layers coincide with a maximum in the precession index and are characterised by reduced organic carbon, higher $d^{18}O$ of planktic foraminifera and enhanced Ti/Al (Nijenhuis, 1999).

This study focuses on Pliocene Trubi sediments from two locations of this outcrop: Lido Rossello (LR) and Punta di Maiata (PM), located ~2 km apart. Both records span three Pliocene precession-forced climate cycles (4.605 – 4.685 Ma) which includes three grey marl sapropel layers (31, 30 and 29). Our research studies lipid biomarkers in order to explore changes in biogeochemical cycling over these three Pliocene climate sequences. Our records demonstrate the presence of both isoprenoidal glycerol dialkyl glycerol tetraethers (GDGTs), including those associated exclusively with ammonia oxidising archaea (Sinninghe Damsté et al., 2002) as well as terrestrial derived branched GDGTs. Beyond enhancing our understanding of in-situ biogeochemical cycling, these biomarkers will allow us to further reconstruct regional sea surface temperatures (TEX_{86} ratio; Schouten et al., 2002), and the relative input of terrestrial organic matter in marine sediments (BIT Index; Hopmans et al., 2004). We will also examine the presence of a range of other biomarker lipids, including heterocyst glycolipids (HGs) in order to examine the role of N_2 fixation by cyanobacteria in stimulating primary productivity.

References:

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