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Paleoecologic and neotectonic evolution of SE Rhodes (Greece) during the early Pleistocene

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Introduction

The recent Eastern Mediterranean Sea is characterized by oligotrophic conditions but little is known whether trophic conditions were comparable in the northeastern Mediterranean Sea region during older time periods such as the early Pleistocene. The Neogene climatic and hydrologic evolution of the Eastern Mediterranean Sea is influenced by orbital changes, leading to the periodic deposition of sapropels. The sapropels formed at times of Northern Hemisphere summer insolation maxima and are linked to phases of enhanced African monsoon activity (e.g., Hilgen, 1991; Rossignol-Strick et al., 1982) resulting in changes in the oxygenation of bottom and pore waters. Changes in trophic conditions and oxygenation of bottom and pore waters, in turn, influence the distribution and microhabitats of benthic foraminifera, particularly in deep-sea environments (Jorissen et al., 1995).

The Eastern Mediterranean Sea is tectonically active since the late Cretaceous closure of the Tethys where the African plate is subducted beneath the Anatolian plate along the Hellenic trench and its eastern extensions, the Pliny and Strabo trenches (Fig. 1A). In this geotectonic context, the island of Rhodes has been affected by two long-term subsidence and uplift phases, one in the early and one prevailing middle Pleistocene, and counterclockwise/anticlockwise rotations in the Plio- and middle Pleistocene (e.g., Van Hinsbergen et al., 2007; Cornée et al., 2019). The early Pleistocene neotectonic evolution of the eastern part of the island of Rhodes is recorded in various onshore sedimentary units consisting of marine sediments. These sediments reflect large-scale subsidence and uplift phases in individual and mostly fault-bound paleo-valleys, although remains unclear to what extent the different paleo-valleys underwent diachronous tectonic motions (e.g., Cornée et al., 2019).

Aims & Methods

Major aim of the study was to provide new insights into the paleoecologic and neotectonic evolution of the southeastern part of the island of Rhodes. In this context, we studied fossil benthic foraminiferal assemblages in 164 sediment samples from a marine sediment section from the Lindos Bay Formation (Pefka E section) deposited at the SE coast of the Island of Rhodes (Fig. 1A) during the early Pleistocene. We further developed a benthic foraminiferal-based transfer function to reconstruct tectonically-driven changes in paleo-water depths.

Results & Discussion

We found a high and constant concentration of eutrophic/low oxygen tolerant species in conjunction with a generally high diversity in the Pefka E sediment section (Fig. 1B). This observation suggests that mesotrophic conditions, with well oxygenated bottom waters, prevailed in the NE Mediterranean Sea region during the early Pleistocene which is in contrast to the recent oligotrophic conditions. The higher food availability might be the consequence of enhanced riverine nutrient influx into the Rhodes basin which led to increased surface productivity and related organic matter fluxes during the early Pleistocene. We further orbital-driven fluctuations in the individual abundances of the most important benthic foraminiferal species. Obliquity-driven changes were found in the relative abundance of *Cassidulina carinata* s.l. in the upper part of the section and are related to a higher food availability during glacial compared to interglacial periods in the Eastern Mediterranean region. Precession-driven changes were observed in the relative abundances of *C. carinata* s.l., *Cibicidoides pseudoungerianus* and *Cibicidoides mundulus*. These changes likely reflect enhanced rain fall and associated prolonged near-coastal phytoplankton blooms at times of Northern-Hemisphere insolation maxima. Most the early Pleistocene deep-sea sapropel intervals are characterized by an increase in eutrophic/low oxygen tolerant taxa and a decrease in oligotrophic taxa in the studied section (Fig. 1B). This suggest a higher and seasonally prolonged riverine runoff and associated phytodetritus fluxes rather than dysoxic conditions at the sea floor at estimated water depths between ~200 and ~600 m during times of sapropel formation in the Eastern Mediterranean deep-sea basins.

Precession-corrected paleo-water depth estimates (Milker et al., 2017) in the Pefka E section indicate a series of substantial vertical tectonic motions during the early Pleistocene with averaged vertical rates between 4 and ~8-10 mm/yr for the respective subsidence-uplift cycles (Fig. 1B). These rates of tectonic movements are rather fast compared to other estimates from Rhodes with 0.32 to 2.4 mm/yr (Cornée et al., 2019) and likely portray local vertical motions of an individual paleovalley rather than long-term vertical tectonic motion of the entire island of Rhodes.

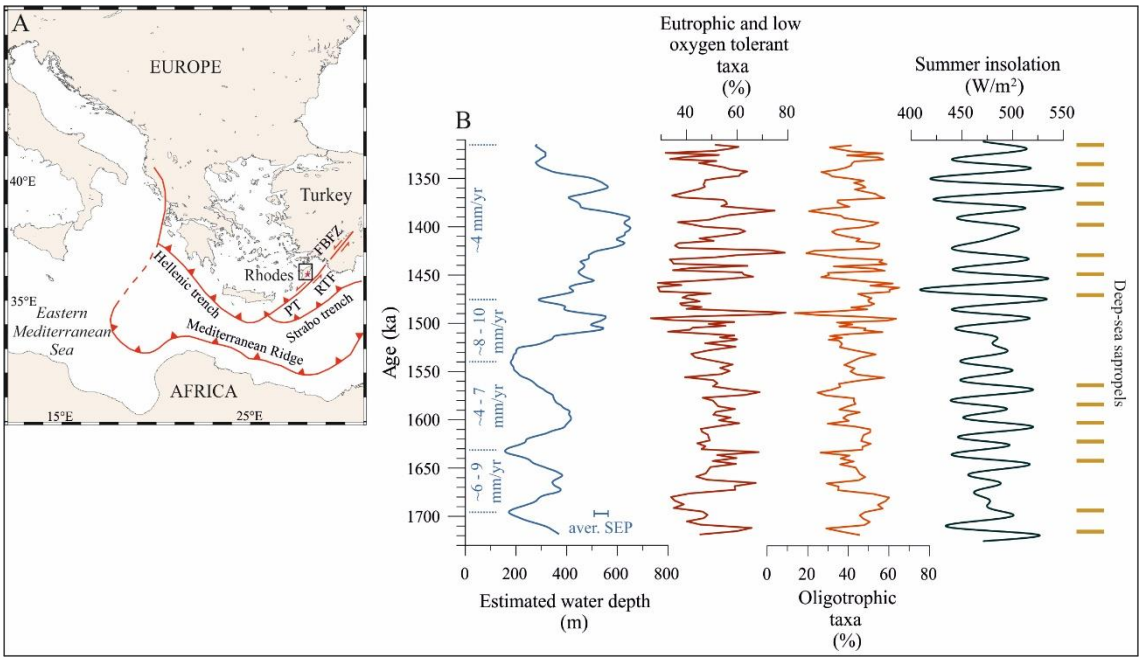

Figure 1. A. Main tectonic features in the Eastern Mediterranean region after Dilek and Sandvol (2009), and Görgün et al. (2014) and references therein (PT = Pliny trench, RTF = Rhodes transform fault; FBFZ = Fethiye-Burdur fault zone). Base map has been created with Ocean Data View (ODV), v. 4.7.10 (Schlitzer, 2017; https://odv.awi.de). B. Precession-corrected paleo-water depths with averaged squared error of prediction (SEP) of the original estimates (Milker et al., 2017) and quantified vertical motions, and relative abundance of eutrophic/low oxygen tolerant and oligotrophic taxa in the Pefka E section versus age. Northern Hemisphere summer (21 June) daily insolation after Laskar et al. (2004). Deep-sea sapropels after Kroon et al. (1998).

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