Multiple crises before the big crisis: Early Messinian Eastern Mediterranean paleoclimate reconstruction inferred from biomarkers and stable isotopes (Crete, Greece)

Geanina-Adriana Butiseaca$^1$, Marcel T. J. van der Meer$^2$, Giorgos Kontakiotis$^3$, Konstantina Agiadi$^4$, Assimina Antonarakou$^3$, Andreas Mulch$^{1,5}$, and Iuliana Vasiliev$^1$

$^1$Senckenberg Biodiversity and Climate Research Centre (BiK-F), Senckenberganlage 25, D-60325 Frankfurt am Main, Germany
$^2$NIOZ Royal Netherlands Institute for Sea Research, Department of Marine Microbiology and Biogeochemistry, the Netherlands
$^3$National and Kapodistrian University of Athens, Department of Historical Geology and Paleontology, Faculty of Geology and Geoenvironment, Athens, Greece
$^4$Department of Palaeontology, University of Vienna, Althanstrasse 14, Geozentrum (UZA II), 1090, Vienna, Austria
$^5$Goethe University, 60438 Frankfurt am Main, Germany

Messinian Mediterranean (7.24–5.33 Ma) was a highly dynamic environment governed by global climatic and regional tectonic activity. The impact of these two environmental factors is highly distinguishable especially during the latest Messinian (5.97–5.33 Ma), when the famous Messinian salinity crisis (MSC) affected the Mediterranean realm. However, the interplay between climate and tectonics is less studied for the earliest Messinian. Here we use biomarker analysis, coupled with compound-specific hydrogen ($\delta^2$H) and carbon isotopes ($\delta^{13}$C), to track changes in the hydrological budget, mean annual air temperature (MAAT), vegetation and reconstruct the sea-land climate conditions in Eastern Mediterranean between 7.2–6.5 Ma. Our data from Agios Myron section on Crete (Greece) confirms a series of drastic environmental changes in the Eastern Mediterranean during the mentioned time interval. $\delta^2$H values of alkenones indicate highly evaporitic events accompanied by shifts in vegetation, from dominant $>$C$_3$ plants to marked increasing dominance of C$_4$, with recurrence of C$_3$ vegetation at ~6.99 and 6.78 Ma respectively. The MAAT data indicate average values of 14$^\circ$C and the overall trend suggests an orbitally paced continental climate, with maximum temperatures registered during eccentricity maxima. The reconstructed paleo-soil pH record follows a stepwise increasing trend towards slightly-alkaline soils, supporting an enhanced open vegetation contribution resulting from the ongoing continentalisation. These results provide new insights into the Messinian environmental conditions of the Mediterranean Sea, suggesting an ongoing restriction after 7 Ma, with multiple restrictive phases marked by increasing intensity until the final MSC event.