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Was Mediterranean region that dry during the Messinian Salinity Crisis?

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Between 5.97-5.33 Ma kilometres-thick evaporite units were deposited in the Mediterranean basin during an event known as the Messinian salinity crisis (MSC). It is generally accepted that the MSC was a dry period, with higher evaporation than precipitation and runoff. However, how dry climate was during the MSC is difficult to assess because a modern analogue is missing. Here we reconstruct hydrological changes in the Mediterranean basin during the MSC using excellently preserved biomarkers extracted from three reference sections for the Messinian evaporites: Monte Tondo, in the northern Apennines, Realmonte salt mine and Eraclea Minoa, in Sicily that cover the main stages of the MSC: the 'Primary Lower Gypsum' (stage 1 of the MSC), halite unit (stage 2) and 'Upper Gypsum' (stage 3) respectively. We used long chain n-alkanes with a strong odd over even predominance as terrestrial biomarkers, and their hydrogen isotopic values (δD) to reconstruct the large scale hydrological changes on the land adjacent to the Mediterranean covering $\sim$640 kyrs of the MSC interval. Additionally, the δD record of long-chain alkenones produced by haptophyte algae is used to observe changes in the source for the Mediterranean Sea water. The δDof thelong-chain n-alkanes recorded during the deposition of Lower Evaporites in Monte Tondo (MSC stage 1) indicate a δD of the precipitation largely similar to the present-day Mediterranean. This implies that the overall hydrologic regime was similar to today, with only some levels being more δD enriched ($i.e.$ more arid/warmer). Enriched δD values of the alkenones from halite unit of the Realmonte mine (MSC stage 2) are associated with kainite (mineral forming under extreme evaporation) and giant polygons (evidence of an exposure surface), in line with the high evaporative conditions during halite deposition. The δDof thelong-chain n-alkanes recorded during the deposition of Upper Evaporites in Eraclea Minoa (MSC stage 3) indicate a δD of precipitation much different from the present-day Mediterranean Sea hydrologic regime. The values are typical for much drier settings, similar to the Red Sea – Gulf of Aden, region known for extreme evaporation taking place today. The relative contribution of the different alkenones from Eraclea Minoa is similar to that observed in present-day marine settings. This implies that a connection to the open Ocean is likely, even though a connection with the Parathetys might have existed as well. However, the $\delta D_{alkenones}$ values recorded during deposition of the Upper Evaporites in Eraclea Minoa are similar to those recorded synchronously in the Black Sea area, DSDP 42B Hole 380. The source for the surface water from the Upper Evaporites was similar to the one from the coeval Black Sea suggesting a similar hydrologic regime characterized by extended drought over large areas of the southeastern Europe. Because of the $\delta D_{alkenones}$ similarity and the alleged Paratethys type of fauna defining the ´Lago Mare´ of the Mediterranean we further speculate that the surface water from the Upper Evaporites could, at times, be derived from the Black Sea, consistent with Paratethys water inflow into the Mediterranean.