Calcareous nannofossil size as a proxy for the Messinian Salinity Crisis dynamics

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Dwarfism is a common feature affecting organisms during and after extreme events that characterized the geological history. The organism size reductions are frequently referred as the result of “stressed condition”. Such changes occurred for instance during Oceanic Anoxic Events and are well recorded in the fossil assemblage of calcareous marine organisms. To date, no study addressed the morphological and biometric changes during the Messinian Salinity Crisis (MSC), one of the most recent and impacting event occurred in the Mediterranean Sea.

Here we focus on morphometric changes affecting calcareous nannofossils at the MSC onset in order to better constrain the paleoenvironmental changes and the “stressed conditions” that characterized this interval. Samples were collected in the Perales section (Sorbas Basin, West Mediterranean) in which size characterization of 50 specimens of 4 different calcareous nannofossil taxa (Helicosphaera carteri, Sphenolithus abies, Umbilicosphaera rotula and Coccolithus pelagicus) was performed in each sample, along with their absolute abundances (number of nannofossils over gram of dry sediment). In order to test the reliability of the obtained data and demonstrate that the size change recorded at the MSC onset was a basin-scale event, 2 sections in the Piedmont Basin (Banengo and Pollenzo), encompassing the same time period were also analysed. In addition, size changes and cyclicity related to orbital forces were addressed in a high temporal resolution size and calcite mass analysis performed on Reticulofenestra minuta, using an automated image analyses system of calcareous nannofossils recognition (SYRACO) on several cycles encompassing the MSC onset.

A significant size reduction affected the calcareous nannofossil taxa involved in the MSC onset biostratigraphic event in both the North and West Mediterranean sections. These morphometric changes were related to the restriction of the Mediterranean Basin, resulting in an increase in both productivity and environmental variability, stimulating calcareous nannofossils growth rate and decreasing their cell and sizes. The R. minuta size and calcite mass correlate with the change in the orbital variability, governed mostly by precession, with minimum values recorded during the cyclical diatomite deposition in the Sorbas Basin. In this case, the size reduction was triggered by the precession-induced enhanced environmental variability that characterized the diatomite deposition.
Our findings highlight the relevance of calcareous nannofossil morphometry and mass to trace the dynamics of extreme events, such as the MSC. Size and mass changes of selected calcareous nannofossils taxa at the MSC onset suggest that “stressed conditions” characterizing this event likely coincide with the instauration of a highly variable environment, linked to the restriction of the paleo Gibraltar strait.