Palaeoenvironmental changes at the onset of the Messinian Salinity Crisis (NW Italy): A microbial perspective

Marcello Natalicchio[1], Daniel Birgel[2], Jörn Peckmann[2], Giorgio Carnevale[3], Francesca Lozar[4], Xiaolei Liu[5], Kai-Uwe Hinrichs[5], Francesco Dela Pierre[6]
[1] Department of Earth Sciences, University of Torino, Italy, marcello.natalicchio@unito.it
[2]Department of Geodynamics and Sedimentology, University of Vienna, Austria
[3]Department of Earth Scinces, University of Torino, Italy
[4]Department of Earh Sciences, University of Torino, Italy
[5]University of Bremen and MARUM, Organic Geochemistry Group, Bremen, Germany
[6]Department of Earth Sciences, University of Torino, Italy

The Phanerozoic giant evaporite basins of the Earth have been formed due to environmental change and were extensively studied by combining sedimentologic and geochemical analyses, however, detailed geomicrobiological studies have not been carried out yet. We present a lipid biomarker study on sediments straddling the onset of the Messinian Salinity Crisis (MSC) in order to evaluate the response of eukaryotes and prokaryotes, but especially Archaea, to the transition from normal marine waters to the peculiar extreme conditions postulated by the traditional model of environmental evolution associated with the salinity crisis. The samples derive from the northernmost fringe of the Mediterranean basin (Pollenzo, NW Italy), where the MSC advent coincides with the deposition of shale and carbonate-rich beds; the latter are considered as deep water counterparts of the shallow water gypsum layers. Both pre-MSC and MSC deposits display similar molecular fossil assemblages, sourced from all three domains of life (Eukarya, Bacteria and Archaea), mainly represented by isoprenoidal alcohols, fatty acids, sterols, long chain *n*-alkanes and *n*-alcohols. After the MSC onset, however, a sharp increase of long chain *n*-alkanes, *n*-alcohols and *n*-fatty acids is observed, indicating a larger input of terrigenous organic matter, most likely sourced by enhanced riverine runoff. Interestingly, this coincides with an increase of sterols (sitosterol and dinosterol) (average ^{13}C –24‰), typically interpreted as markers of algal blooms possibly reflecting eutrophication. In addition, Archaea flourished, mainly reflected in the biomarker patterns by the archaeal membrane lipids including glycerol dibiphytanyl glycerol tetraethers (GDGTs) and diphytanyl glycerol diethers (DGDs). Whereas the occurrence of GDGT-5 (caldarchaeol) is a good indicator of a “normal” marine water column during the early phases of the MSC (planktic *Thaumarchaeota* are the most likely source organisms), a sharp increase of DGDs (especially extended archaeol, which is only sourced by halophilic archaea) indicates a profound change in the archaeal community structure after the advent of the crisis. Most likely this increase reflects a bottom seawater salinity rise. This study highlights that lipid biomarkers are excellent recorders of changing environmental conditions that led to the formation of ancient evaporite giants.