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Archaea were widespread in sediments of the Messinian Salinity Crisis

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The Messinian salinity crisis (MSC) was among the most extreme and short-lived paleooceanographic events in Earth history and dramatically impacted the depositional environments of the Mediterranean. Many of the Messinian sedimentary sequences reflect environmental variability on extremely short time scales, typified by phenomena like evaporation and high salinities, anoxia, and desiccation. Only few organisms tolerate such severe conditions. Among those are archaea, many of which are especially well adapted to extreme conditions. We studied various MSC locations and deposits to shed light onto the role of archaea in the MSC, focusing on lipid biomarkers. These are (1) primary gypsum with abundant, yet problematic filamentous microfossils from various locations in the Mediterranean, (2) Calcare di Base, limestones from Sicily and Calabria, and (3) Calcare Solfifero, authigenic carbonates associated with native sulfur from Sicily.
(1) Primary gypsum beds with abundant filamentous fossils are widespread in the Mediterranean. Archaea were found as important contributor of organic matter in these evaporites. The filaments, however, have previously been interpreted to represent cyanobacteria based on the extraction and amplification of cyanobacterial DNA. Cyanobacteria produce specific and long-lasting biomarkers, but no such compounds were found in the studied deposits, thus, the assignment of the filaments to cyanobacteria necessitates further verification. (2) The Calcare di Base are widespread, genetically heterogeneous Messinian limestones, which are particularly common in Sicily and Calabria. The environmental conditions during their deposition, as well as mechanisms and timing of formation are a matter of debate. The studied Calcare di Base samples were found to contain specific halophilic archaeal signatures and numerous pseudomorphs after halite. (3) The Calcare Solfifero, authigenic carbonates accompanied by elemental sulfur formed in the course of microbial sulfate reduction. One of the important processes fuelling authigenesis was microbial oxidation of methane. Lipid biomarker patterns reveal that a consortium of methanotrophic archaea and sulfate-reducing bacteria consumed methane in anoxic and hypersaline environments. Halophilic archaea other than those archaea involved in methane oxidation have been present in the depositional environment as well. This as to yet still somewhat random selection of examples provides evidence for the great diversity of environmental settings created during the MSC and the abundance of archaea in these environments, calling for more work on the geomicrobiology of the unrivaled archive of dramatic paleooceanographic change during the MSC.