Geophysical Research Abstracts
Vol. 18, EGU2016-18161, 2016
EGU General Assembly 2016

Molecular fossils of prokaryotes in ancient authigenic minerals: archives of microbial activity in reefs and mounds?

Katrin Heindel (1,2), Daniel Birgel (3,1), Sylvain Richoz (4), Hildegard Westphal (5), Jörn Peckmann (3,1)

(1) Department of Geodynamics and Sedimentology, University of Vienna, Vienna, Austria (katrin.heindel@univie.ac.at), (2) GeoZentrum Nordbayern, Palaeontology, University of Erlangen, Erlangen, Germany (current address), (3) Institute of Geology, University of Hamburg, Hamburg, Germany (daniel.birgel@uni-hamburg.de), (4) Institute of Earth Sciences, University of Graz, Graz, Austria (sylvain.richoz@uni-graz.at), (5) Leibniz Center for Tropical Marine Ecology, Bremen, Germany (director.zmt@leibniz-zmt.de)

Molecular fossils (lipid biomarkers) are commonly used as proxies in organic-rich sediments of various sources, including eukaryotes and prokaryotes. Usually, molecular fossils of organisms transferred from the water column to the sediment are studied to monitor environmental changes (e.g., temperature, pH). Apart from these ‘allochthonous’ molecular fossils, prokaryotes are active in sediments and mats on the seafloor and leave behind ‘autochthonous’ molecular fossils in situ. In contrast to many phototrophic organisms, most benthic sedimentary prokaryotes are obtaining their energy from oxidation or reduction of organic or inorganic substrates. A peculiarity of some of the sediment-thriving prokaryotes is their ability to trigger in situ mineral precipitation, often but not only due to metabolic activity, resulting in authigenic rocks (microbialites). During that process, prokaryotes are rapidly entombed in the mineral matrix, where the molecular fossils are protected from early (bio)degradation. In contrast to other organic compounds (DNA, proteins etc.), molecular fossils can be preserved over very long time periods (millions of years). Thus, molecular fossils in authigenic mineral phases are perfectly suitable to trace microbial activity back in time.

Among the best examples of molecular fossils, which are preserved in authigenic rocks are various microbialites, forming e.g. in phototrophic microbial mats and at cold seeps. Microbialite formation is reported throughout earth history. We here will focus on reefal microbialites form the Early Triassic and the Holocene. After the End-Permian mass extinction, microbialites covered wide areas on the ocean margins. In microbialites from the Griesbachian in Iran and Turkey (both Neotethys), molecular fossils of cyanobacteria, archaea, anoxygenic phototrophs, and sulphate-reducing bacteria indicate the presence of layered microbial mats on the seafloor, in which carbonate precipitation was induced. In association with metazoans other than corals (sponges, bivalves, gastropods, ostracods) and foraminifera, first metazoan-microbialite reefs developed on the Early Triassic seafloor.

After the last glacial maximum, microbialites formed in coral reefs. Our evidence shows that sulphate-reducing bacteria played an intrinsic role in the precipitation of these microbialites during the Holocene sea-level rise. With more nutrients and organic matter distributed in the reef ecosystem, anoxic microenvironments preferentially developed. Such conditions favored heterotrophic bacteria, particularly, sulphate-reducing bacteria. It is suggested that matrix-solute interaction related to the activity of sulphate reducers induced carbonate precipitation in extracellular polymeric substances.

Overall, authigenic mineral phases from various environments can be used as excellent archives to describe former microbial activity in sediments. The early entombment of the lipids in the mineral matrix avoids the loss of specific and important information, which may have been lost in soft sediments rather quick.