Formation of microbialites in Holocene coral reefs and on early Triassic ocean margins

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During the Precambrian and Early Phanerozoic, reefal structures were built by microbialites. Since the Middle Ordovician, reefal microbial carbonates were associated with skeletal metazoans, which succeeded in an overall decline in microbialite occurrences. However, during environmental crises, microbialites have been major components of marine ecosystems throughout Earth history.

In Holocene post-glacial coral reefs, the occurrence of microbialites has been interpreted to reflect an ecosystem response to environmental change. The microbialites are well preserved and volumetrically abundant, offering an excellent opportunity to study formation mechanisms. Our evidence shows that sulfate-reducing bacteria played an intrinsic role in the precipitation of microbial carbonate in coral reefs off Tahiti, Vanuatu, Belize and the Maldives. With more nutrients and organic matter distributed in the reef ecosystem during the last sea-level rise, anoxic microenvironments preferentially developed. Such conditions favored heterotrophic, particularly, sulfate-reducing bacteria. It is suggested that matrix-solute interaction related to the activity of sulfate reducers induced carbonate precipitation in extracellular polymeric substances.

In contrast, after the End-Permian mass extinction, microorganisms formed microbialite bioherms, which covered wide areas on the Early Triassic ocean margins due to the lack of metazoan reef builders. Well preserved microbialites from Iran and Turkey (both Neotethys) were studied for their lipid biomarker inventories. Molecular fossils of cyanobacteria, archaea, anoxygenic phototrophs, and sulfate-reducing bacteria indicate the presence of layered microbial mats on the seafloor. In association with metazoans other than corals (sponges, bivalves, gastropods, ostracods) and foraminifera bioherms developed on the ocean margins. In contrast to reef-microbialite formation in the Holocene, the biomarker evidence suggests that photosynthetic CO_2 removal by cyanobacteria possibly contributed more significantly to carbonate precipitation.