Carbonate build-ups in extreme settings: insights from recent and ancient systems

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Carbonate mound systems represent a recurrent strategy of Life and an exemplary mode of Geosphere-Biosphere coupling throughout Phanerozoic times. The primary building bricks of carbonate mound systems do vary through space and time as a consequence of subtle environmental changes, turning such systems into a challenging but interesting palaeo-environmental archive. Scrutinizing parallelisms and contrasts between mound systems in the present ocean and the geological record deepens our insights in the basic drivers. It should be noted that microbes play a particular role in the evolution of such mound settings.

Microbial carbonate systems seem to be the key to understand the tipping points in mound evolution. Microbial-influenced mound systems especially thrives under extreme conditions, whereby ‘extreme environment’ refers to any setting that exhibits life conditions detrimental or fatal to higher organisms with respect to its physicochemical properties (Thiel et al., 2012). New views on microbial processes, actors and products emerge through new insights in extreme carbonate environments (encompassing acidic, alkaline, hypersaline, pressurized, hot, cold and dry environments). So, the study of ‘extreme’ or - better rephrased as ‘frontier’ - carbonate systems forms the true cornerstone to understand the processes in carbonate mound factories through space and time. Starting from recent observations of cold-water coral carbonate mounds in the cool-water realms as ‘frontier carbonate systems’, other mound systems in stressed environments are further explored.

Generalizing the marine carbonate precipitation modes conform Schlager (2003), one can talk about three different primary ‘carbonate mound’ factories (Foubert et al., in prep.): (1) the *biotically-controlled mound factory* dominated by biotically-controlled skeletal production resulting in typical *bioclastic mounds*, (2) the *biotically-mediated mound factory* dominated by (mostly) microbial-induced carbonate precipitation such as often recognized in *mud mounds* and, (3) the *abiotic mound factory* characterized by abiotic (physico-chemical) precipitation modes, for example *travertine mounds* and *spring mounds*. However, most of the observed mounds thriving under ‘extreme’ conditions are a product of the tight coupling between biotically-controlled, biotically-mediated and abiotic precipitation. For example, travertine build-ups witness a tight interaction between abiotic and microbial-induced precipitation, recording at a high time-resolution (due to high precipitation rates) the response of microbial communities to environmental change. Moreover, travertine deposits and microbial build-ups have played a crucial role in the initial phases of ocean spreading.

The renaissance in the study of the substantial role of microbes in syn-rift carbonates might hold clues to understand microbe-mineral relations and the tight coupling between microbial-induced and physico-chemical precipitation.

It should be noted that carbonate mounds are highly sensitive to the early diagenetic filter and act on their turn as biogeochemical micro-reactors catalyzing dissolution and (microbial-induced) precipitation of carbonate phases (Foubert and Henriet, 2009). Last is often obscuring the primary precipitation modes.

References

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