**HYBRID CARBONATES: ABIOTIC-MICROBIAL-SKELETAL**

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In situ Hybrid Carbonates1 are intimate combinations of two or more of abiotic (e.g., seafloor sparry crust), microbial (e.g., stromatolite) and skeletal (e.g., reef) carbonates. They reflect elevated carbonate saturation state, at least locally, since their formation requires precipitation of abiotic or microbial carbonates. Hybrid carbonates are widespread and diverse in the marine geological record and in present-day non-marine carbonates. Their marine history reflects major changes in carbonate precipitation through time.

Widespread abiotic-microbial hybrids have confused definition, recognition and interpretation of Precambrian stromatolites. Microbial-skeletal hybrids are common in many Phanerozoic reefs, particularly during intervals of abundant microbial carbonates (e.g., Cambrian archaeocyath and Jurassic lithistid sponge reefs), and during microbial carbonate-skeletal carbonate transitions (e.g., early Ordovician, Late Devonian). Even in well-developed skeletal framework reefs (e.g., Ordovician-Devonian), cryptic microbial carbonates often created hybrid fabrics, and these continue to be locally significant in late Cenozoic coral frameworks. More complex abiotic-microbial-skeletal hybrids developed when sparry seafloor crusts also formed, as in much of the Permian (e.g., Capitan reef) and Triassic (e.g., Cipit reef blocks). In situ hybrid fabrics are also common in deeper water methane seep mounds and hot-water carbonate vent pinnacles (e.g., Lost City). Diverse abiotic-microbial spring, creek and lacustrine carbonates, as well as microbial-insect tufa, develop in non-marine environments.

Over time, intervals of Hybrid Carbonate abundance contrast with those of the ‘classic’ carbonate end members (abiotic, microbial, skeletal) that compose them. Thus, the question arises, which are more abundant, these end-member categories, or the mixtures of them that create Hybrid Carbonates? The answer depends greatly on time-period and environment. Overall, we suggest that Hybrid Carbonates are more widespread and abundant than ‘Classical Carbonates’. Studies of the nature, variety and distribution of Hybrid Carbonates will provide insights into long-term changes in marine carbonate precipitation, and into the fabrics and formation of reefs, stromatolites, travertine and tufa.

**References**

1 Riding, R., *Geologia Croatica*, 2008, **61**, 73.

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