

Nature and Scales of Autogenic Processes in Carbonate Sedimentary and Geomorphic Systems

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Born of the ocean, marine carbonate sediments and strata are intimately tied to a spectrum of physical, chemical and biological processes. Although tectonics and sea-level change (allogenic factors) play important roles in their stratigraphic evolution and preservation, these interact with a host of processes operative within the depositional systems (autogenic processes) at a range of spatial and temporal scales.

At the most fundamental level, because of their biologic and physiochemical origins, the type of carbonate grains and constructions are intimately tied to the environment in which they originate. Once produced, however, they can modify their environment, which can in turn influence the production of sediment. Two illustrative examples of such dynamics are found in reefs (that create bathymetric highs, which in turn favor further reef growth) and ooid shoals (that, with shallowing and enhanced flow, create the sediments that make up the shoal). At a larger scale, many carbonate seascapes produced by these types of interactions also include systematic or repeated geomorphic motifs (some with broad parallels in siliciclastic systems). Some landscape themes persist across a range of geologic ages and constituent biota or sediment types, suggesting the primary role of feedbacks among sediments/biota, hydrodynamics, and bathymetry in their emergence.

A unique aspect of carbonate sediments is the occurrence of early syndepositional cementation, which can be intimately linked to, and in turn influence, depositional processes. In ooid shoals, enhanced tidal flows controlled by the very presence of the shoal drive large volumes of supersaturated marine waters through the shallow subsurface, favoring marine cementation. Similarly, some shoals aggrade above sea level and are subjected to early meteoric diagenesis. Once cemented, submarine hardgrounds and cemented beaches can inhibit erosion, favoring geomorphic preservation.

Collectively, these examples illustrate some of the autogenic processes active in carbonate systems. Because of time-variance in biota, inherent complexity from multiple controls, and lack of amenability to scaling, a major challenge in carbonates remains delineation of objective criteria for discerning and extracting their impact on the stratigraphic record and utilizing these insights for meaningful prediction.