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Carbonate factories through the Earth History

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Changing components, rock textures, lithofacies, platform types and architecture throughout time are unique characteristics of carbonate rocks. Characterizing these attributes for the Phanerozoic has been approached by 1) building reference models for specific time intervals (mostly for reefs and mounds); 2) recognizing the climatic impact in modulating carbonate production (e.g., cool-water, temperate-water and mud-mound factories); 3) analyzing the influence of changing bio-geochemical conditions (e.g., aragonitic vs. calcitic seas). To date, however, analyses integrating all of these factors are still missing, as there are missing integrative and comparative analyses for the whole Earth History (Archean to Neogene).

The integrative analysis here presented evidence the key factors controlling the changes in carbonate production modes at different time scales. For the whole Earth History, carbonate production modes parallel the evolutive trend of photoautotrophy, and secondarily, also in mixotrophy and in the consumers (heterotrophy). Higher temporal resolution for the Phanerozoic, despite the numerous evolutive innovations, crashes, and extinctions, additionally evidences the impact of varying atmospheric CO_2 and Ca++ in seawater. Higher temporal resolution in the proxies for the Cenozoic furthermore attests to the influence of changes in global temperature and nutrients-oceanic circulation (d13C).

To conclude, the analysis here presented, evidences the photosynthesis to be the prime driver inducing and controlling carbonate production. Secondary drivers are the factors influencing the metabolic rates of primary producers and consumers (CO_2 concentration, nutrients, and temperature), and calcification (Ca++). As HCO_3- is the most abundant Carbon source in alkaline waters, but it is inaccessible without a source of protons, the different carbonate production modes are the expression of the way the proton acceptor (photosynthesis) captures the protons from the donor (carbonate precipitation).