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Precise U-Pb dating of Cenozoic tropical reef carbonates: Linking the evolution of Cenozoic Caribbean reef carbonates to climatic and environmental changes.

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Coral reefs are very diverse and productive ecosystems; and have long been the base of the economic activity of several countries along the tropics. Because coral reefs are very sensitive to environmental changes and their adaptation to changing stressing conditions is very slow, the combination of current rapid environmental changes and the additional stresses created by growing human populations (i.e. rapid anthropogenic CO_2 additions to the atmosphere),plus the economic and coastal development may become a lethal synergy.
The ongoing acidification of modern oceans is a major issue of concern because it may have serious consequences for the survival of shelly marine invertebrates as the 21st century progresses. Ocean Acidification (OA) is now being driven by rapid CO_2 release to the atmosphere. Although evidences of the devastating effects of oceanic acidification in the marine biota are provided by the decreased rate of coral skeleton production and the reduced ability of algae and free-swimming zooplankton to maintain protective shells, among others, predicting the effects of oceanic acidification on the future oceans (2050-2100) has remained rather difficult because the atmospheric CO_2 sequestration by the global oceans occurs in geologic time scales.
Important changes in the atmospheric pCO_2 and major climatic/environmental events seem to have controlled the evolution of the Cenozoic equatorial-tropical carbonates r1-10. Rapid additions of green house gases to the atmosphere occurred during the Paleocene-Eocene transition and would have promoted several other events of global warming until the early Oligocene (i.e. the Eocene thermal maximum). These periods of high greenhouse gases concentrations would have also resulted on OA, affecting the reef carbonate ecology and tropical carbonate budgets.
Relating temporal variations in the Cenozoic reef carbonate structure, ecology and factory is vital to help understanding and predicting the future effects of the rapid anthropogenic CO_2 release to the atmosphere on reef areas. Here we report precise U-Pb ages of several Cenozoic Caribbean-tropical reef carbonate successions along the SE Circum-Caribbean Region from which major temporal variations in the reef carbonate factories, structure and ecology are related to major climate/environmental changes.
Calcareous algae are the principal calcifying reef builders along the SE Circum-Caribbean during the Paleocene-middle Oligocene interval, a period of predominant high atmospheric pCO_2 and OA. Calcareous algae persisted as the main calcifying reef builders until the late Oligocene when atmospheric pCO_2 levels dropped, allowing the onset of global icehouse conditions and the appearance of corals as the main calcifying reef builders along the SE Circum-Caribbean. Coral reefs would have dominated until the middle Miocene, when a new period of calcareous algae reefs occurred along the Caribbean, coinciding with the Miocene thermal optimum in mid-latitude areas (i.e. the Mediterranean). Coral reef carbonates dominated since the Pliocene. From the data presented here we suggest that calcareous algae dominated were the main calcifying reef builders during periods of warm temperatures and pronounced environmental change in the tropical seas (i.e. OA). Corals would have conversely dominated as main calcifying reef builders during periods of optimal tropical climatic/environmental conditions. Comparisons between this geologic conditions and data for the period 1984-2006 in the Caribbean11 suggest that the transition from corals towards calcareous algae is repeating again.

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