CALCITE CONCRETIONS TO REFINE THE MARINE-TO-NONMARINE (SEQUENCE) BOUNDARY

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PROJECT OBJECTIVES

- To use calcite concretions, a product of cementation by marine seawater, to better constrain the position of the marine-to-nonmarine deposition in a tropic mixed system.

PROJECT RATIONALE

Here we investigate the usefulness of calcite concretions to better identify and constrain the transition from marine sediments to non-marine sediments at the sequence boundary in a mixed system. We propose that calcite concretions with a stable isotope signature (-10 to -25 ‰ $\delta^{13}C$) that reflects bacterial sulfate reduction (BSR) and sometimes an isotopic signature of oxidation of methane (< -25‰ $\delta^{13}C$) are formed exclusively in the marine realm. When present, the distribution of concretions can be used across the lowstand-related deposits to refine placement of the actual sequence boundary. More specifically, the uppermost concretions better constrain the marine to non-marine boundary. Similarly, during the subsequent transgression the lowermost concretions can help mark the transition of non-marine to marine deposits where marine fossils are often absent.

SCOPE OF WORK

The Miocene-Pliocene mixed system of the Cibao Basin, Dominican Republic (DR) is a young, unconsolidated, undeformed shelf clinothem set. Our extensive work in the basin has identified several well-exposed sequence boundaries where concretions occur prior to subaerial exposure and fluvial deposition, as well as during the marine flooding at the end of exposure. The Yaque Group contains three depositional sequences (Cercado, Gurabo, Mao Fm.) where we will examine the isotopic composition of the calcite concretions and map their distribution across at least two sequence boundaries (one from falling sea level, one from rising

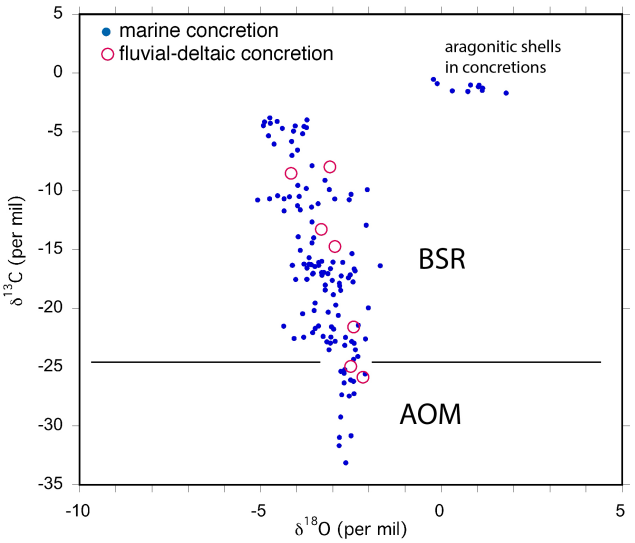

Figure 1. Crossplot of stable isotope data from calcite marine concretions (blue dots) and data from a concretion in the fluvial-deltaic sand and gravel (red circles) from the contact between Gurabo and Mao formations on Rio Cana.

sea level). We have tested one concretion at the sequence boundary between the Gurabo and Mao formations (Fig. 1). This test site has a series of calcite-cemented sand beds in the coarse gravel unit that overlies the marine silt lithofacies typical of the outer shelf. The lithified sand beds have calcite cements with carbon isotope values that range from outer edge values of -15‰ to center values of -25‰. These values are consistent with DR concretions formed under conditions of sulfate reduction. Sampling cemented beds across at least two sections that span a sequence boundary will test these initial results. The first section will be the transgression and shift from fluvial gravel to marine sands at the base of the Mao Formation. A second site (Fig. 2) will sample the section across the Gurabo Formation-Mao Formation sequence boundary at Rio Cana where marine deposits transition to sand and gravel beds and fluvial lithofacies.

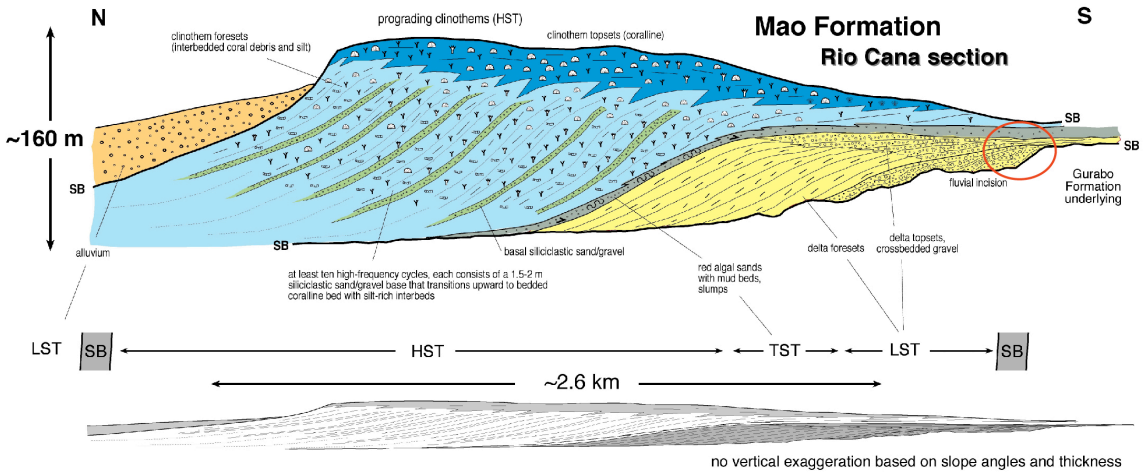

Figure 2. Schematic of the Mao Formation depositional package. This study will follow the occurrence of marine calcite concretions across the sequence boundary outcrop show by the red circle at the base of the Mao Formation. The initial data shown in Figure 1 indicates that concretions can form in the fluvial-deltaic deposits during the fall of sea level and eventual exposure. This project will characterize the nature of cementation across the boundary to test our hypothesis.

DELIVERABLE PRODUCT

This study is a proof-of-concept to evaluate the potential to use marine concretions, in circumstance where they occur, to provide a means of refinement to the boundary between marine and nonmarine lithofacies. Where concretions occur, especially in the mixed system, they may be reliable markers of the change from, or to, marine deposition.