COMPARISON OF ISOTOPIC PATTERNS IN THE PACIFIC AND ATLANTIC: C AND O

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PROJECT OBJECTIVES

 Determine the role of global sea-level changes in controlling patterns in C and O isotopic composition of bulk carbonates and C isotopic composition of organic material.

PROJECT RATIONALE

While large negative excursions in carbonate and organic carbon δ^{13} C values during the Neoproterozoic and Paleozoic have been interpreted as records of global carbon cycling (Halverson et al., 2002; Halverson et al., 2010), in some instances these sediments do not record global changes in the Carbon (C) cycle, but rather variations in source and diagenesis. Such interpretations have profound implications for the use of δ^{13} C values in stratigraphic correlations and for reconstructions of the global C cycle throughout the Earth's history.

<u>Sources of Carbonate</u>: The assumption that δ^{13} C values record the composition of the global pool of dissolved inorganic C was tested by examining the δ^{13} C values of sedimentological sequences recovered from a transect of cores drilled off a modern carbonate platform in the Bahamas (Great Bahama Bank) which had been independently dated (Swart and Eberli, 2005). This study revealed that while the δ^{13} C values of the sequences were similar, and therefore could be used for stratigraphic correlation, the δ^{13} C values were not related to the global record of δ^{13} C values found in the shells of planktonic organisms. Rather the variations were related to sea-level controlled input of carbonate with distinct δ^{13} C values originating from adjacent platforms. Evidence from other Modern platforms such as in The Maldives, The Great Barrier Reef, and The Great Australian Bight show that this process is global (Swart, 2008).

Sources of Organic Material: One of the key pieces of evidence which has been used to support the original nature of the carbonate δ^{13} C values is the covariance of δ^{13} C values in the carbonate and organic carbon in the same deposit. However, it has been shown in a study of carbonates deposited over the past 5 myrs adjacent to Great Bahama Bank that varying correlations (~ +1 and 0) between the δ^{13} C values of organic and inorganic carbon can be the result of different degrees of mixing between materials derived from different sources (Oehlert et al., 2012). In fact, the strongest correlations arise in situations where there is mixing between two sources with distinctive δ^{13} C values. Such variations are unrelated to changes in the global carbon cycle. Similar patterns have been found at locations adjacent to other modern carbonate platforms.

<u>Diagenesis:</u> It is well known that during the Pleistocene global sea-level fell numerous times subjecting shallow-water carbonates to meteoric influence



Figure 1: Comparison of the record of δ^{13} C values from locations in the Atlantic (Unda, Stock Island, and Clino) with the Enewetak record of Quinn (1991)

and the global benthic record (Zachos et al., 2001). Data from Unda, Clino are from Melim et al. (2001) and from Stock Island from Melim et al. (2004).

and impacting the δ^{13} C values of the carbonates. Changes of similar magnitude and over equivalent depth intervals have been documented during time periods such as the Neoproterozoic, but in these cases the changes have been interpreted to be original (Hoffman et al., 1998). One of the prime pieces of evidence, cited by many workers, supporting the original nature of the changes in δ^{13} C values is that the changes in the Neoproterozoic are global in nature and therefore could not be a result of local diagenesis. However, global sealevel changes will influence sediments in all localities in the same manner and therefore the Pleistocene in the Bahamas should look very similar to a Pacific atoll, such as Enewetak.

SCOPE OF WORK

We have already carried out several studies of the variation of $\delta^{13}C$ and $\delta^{18}O$ values on the cores from the Bahamas (Clino and Unda) (Melim et al., 2001; Oehlert and Swart, 2019; Swart and Oehlert, 2019) and compared the $\delta^{13}C$ values with published data from Enewetak (Quinn, 1991) and the global



Figure 2: Variations in the $\delta^{13}C$ and $\delta^{18}O$ values from Clino (red) (Melim et al., 2001) and Modern surface sediments (green) (Swart et al., 2008) compared to variations in Neoproterozoic carbonates associated with the Trezona anomaly (Halverson et al., 2002) interpreted to reflect changes in the global carbon cycle. The carbonates from Clino have been clearly diagenetically altered, but fall in the same C and O space as samples which have been interpreted as being original in the Neoproterozoic.

benthic record (Zachos et al., 2001) (Fig. 1). Our conclusion was that similar global variations in the patterns of δ^{13} C values can occur and are probably related to sea-level changes and the development of meteoric zones of diagenesis in the Pacific and the Atlantic. In order to study these correlations in more detail we have collected a significant amount of new material from the Enewetak cores and are in the process of preparing these samples for XRD and stable isotope analyses. These studies will be carried in conjunction with similar investigations of trace elements variations.

SIGNIFICANCE

These studies will provide a detailed comparison of δ^{13} C values of carbonate and organic carbon and variations in δ^{18} O values between two sites known to have been influenced by a global change in sea level. Key questions which will be answered deal with the extent that global changes in δ^{13} C values can be caused by global scale diagenetic events induced by sea-level variations and whether such process are responsible for the variations in δ^{13} C and δ^{18} O values observed in Neoproterozoic rocks (Fig. 2).

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