Correlation of the Carbon Isotopic Composition of Organic Material Along a Platform-Basin Transect: Implications for the Use of Carbon Isotopes for Stratigraphic Purposes

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Project Purpose

The carbon isotopic composition of periplatform sediments deposited over the past 10 million years on the Great Bahama Bank (GBB) does not agree with the $\delta^{13}C$ record of pelagic sediments used in global reconstructions. A remote possibility exists that the $\delta^{13}C$ of the periplatform sediments may have been affected by diagenesis; therefore, we have examined the $\delta^{13}C$ of the organic material. A positive correlation between the $\delta^{13}C$ of the organic and inorganic fractions would preclude the possibility of diagenetic alteration. Currently, four cores recovered from ODP Leg 166 have been used to characterize the relationship between the inorganic and organic fractions in periplatform sediments (Figure 1). Both fractions have been analyzed in each core to a

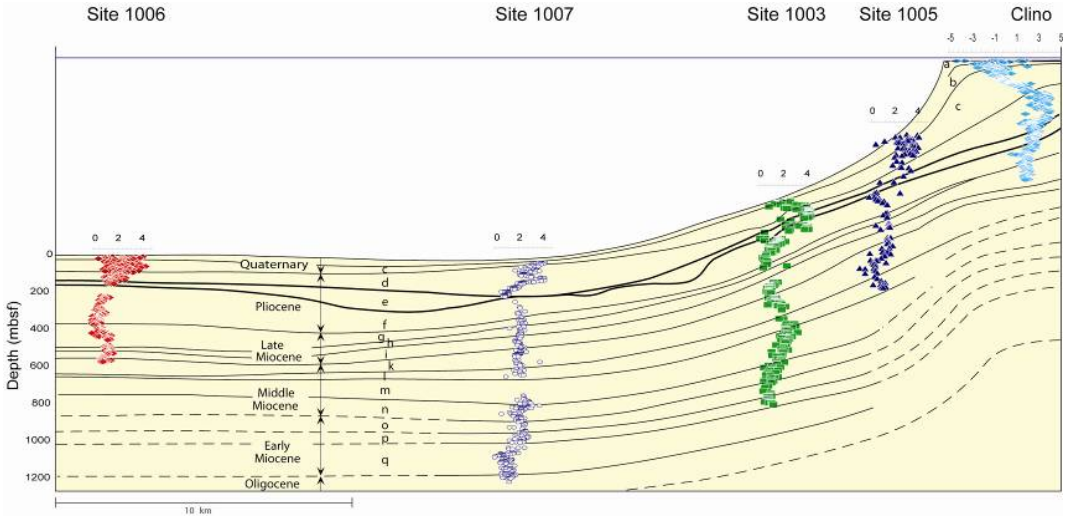

Figure 1. Profile of GBB, showing location of cores analyzed with inorganic carbon records overlaying seismic sequences.

depth of 150 meters below sea floor (mbsf). This current phase of the project aims to extend the records of $\delta^{13}C$ of the organic material to the bottom of each of the four cores, allowing the characterization of both carbon isotopic records at GBB from the late Oligocene to the recent past. High-resolution sampling and analysis of cores 1003, 1005, 1006, and 1007 will be used to evaluate spatial variations in the carbon isotopic records, as well as to assess the validity of calculating pCO_2 from the difference between organic and inorganic carbon fractions.

Scope of Work

The transect of cores recovered off the margin of Great Bahama Bank during Leg 166 all exhibit the same pattern in inorganic carbon composition over the past 10 myr (Swart, 2008; Swart and Eberli, 2005). It was suggested that the consistent patterns identified between the various sites relates to the relationship between platform productivity and sea level cycles. During sea level highstands, the carbonate factory is in full production mode, and exports coarse-grained, platform carbonate material to the slope. In contrast, platform exposure during sea level lowstands shuts off the carbonate factory, resulting in low stand deposition of primarily pelagic sediments. Supporting evidence for this hypothesis is provided by the analysis of the $\delta^{13}C$ of organic material. The $\delta^{13}C$ of organic material from the sediments produced on the platform surface is significantly more positive than the pelagic organic material, therefore patterns of highstand productivity should be identifiable in the organic carbon record.

During the next phase of the project, we will extend the records of inorganic and organic carbon isotopes of sediments recovered along the entire Bahamas Transect on the leeward side of Great Bahama Bank during ODP Leg 166. The extended records from the cores at ODP Sites 1003-1007 will be used to identify whether or not this pattern has been consistent throughout geologic time. The isotopic data will be related to sedimentary units associated with the sequence boundaries identified in the Initial Report of ODP Leg 166.

Key Deliverables

The results of this project will provide new insights into (i) the correlation between the inorganic and organic carbon fractions measured in the basin sediments, and its subsequent degradation in the middle and upper slope cores, (ii) the utility of using stable carbon isotopes for stratigraphic correlation, and (iii) the use of the difference in the $\delta^{13}C$ between organic and inorganic components as indicators of the pCO_2 in the atmosphere.

Project Description

The $\delta^{13}C$ of organic and inorganic components will be measured on sediments collected from cores drilled during the ODP Leg 166. Initial data demonstrate a strongly positive correlation (r^2=0.512) between organic and inorganic fractions in the basin sediments collected from ODP Site 1006. This relationship breaks down at the toe-of-slope of Great Bahama Bank (Site 1007), and continues to disintegrate

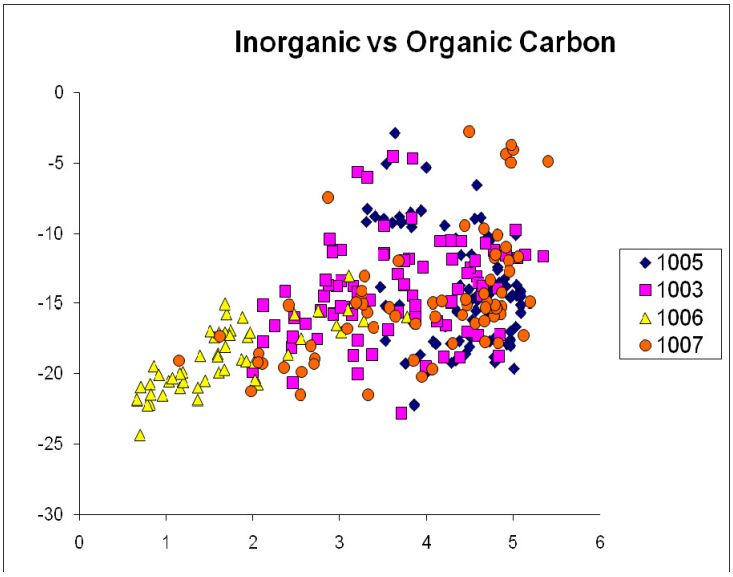

Figure 2. Plot of inorganic vs. organic carbon isotopes.

until the upper slope (Site 1005), where this relationship shows the potential to reverse (Figure 2). The next phase of this project will extend the depths of the organic carbon isotopic record in order to clarify these relationships, and will consider the effects of spatial changes in source variability during platform development.

The records generated by this study will result in a ~20 myr record of carbon isotopic composition of an active shallow marine carbonate platform. Therefore, a unique dataset highlighting the relationship between inorganic and organic carbon fractions in periplatform sediments will be assembled. Furthermore, the application of carbon isotopes in creating stratigraphic correlations and their utility in the estimation of pCO_2 will also be evaluated. The results of these analyses will provide a modern analog to uplifted shallow marine carbonate platforms with similar development histories such as the Maiella platform in Italy (Eberli et al., 2004) .

References

Eberli, G. P. Anselmetti, F.S., Betzler, C. Van Konijnenburg, J.-H., and Bernoulli, D., 2004, Carbonate platform to basin transition on seismic data and in outcrop – Great Bahama Bank and the Maiella platform, Italy. In Eberli, G.P., Massaferro, J.L., Sarg, J.F. (eds.) Seismic Imaging of Carbonate Reservoirs and Systems, AAPG Memoir 81, p. 207-250.

Swart, P. K. (2008), Global Synchronous Changes in the Carbon Isotopic Composition of Carbonate Sediments Unrelated to Changes in the Global Carbon Cycle, Proceedings of the National Academy of Science, 105, 13741-13745.

Swart, P. K., and G. P. Eberli (2005), The nature of the d13C of periplatform sediments: Implications for stratigraphy and the global carbon cycle, Sedimen. Geol., 175, 115-130.