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**Fluctuation in surface water fertility during OAE1b in
the Blake Nose Scarp**

Background

The Mid-Cretaceous warm period was characterized by several periods of intense carbon burial in marine sediments (Erbacher et al., 2001, Leckie et al., 2002, Vermeiji, 1995). These sediments contain high total organic content (TOC), and represent ocean wide anoxic events (OAE) (Wilson et al, 2001). A wealth of

Cretaceous research has been devoted to the discovery of mechanisms that rapidly shut down systems controlling decomposition of organic material in the world's ocean. Studying Cretaceous ocean wide anoxic events will improve understanding of the general dynamics of Earth's climate system during rapid disturbance of the carbon cycle (Norris et al, 2001).

Upper Aptian/lower Albian sediment recovered from the Blake Nose (located in the Atlantic Ocean off the east coast of Florida), on ODP Leg 171b, at site 1049, consists of marl and calcareous chalk with a low TOC content. This lithology is interrupted by 46cm black shale interval, with a high TOC (6%), that is distinguished as OAE1b (Kuypers et al., 2002). Research on the cause of OAE1b is based largely on sediment from the Vocontian Basin in Southeast France (Erbacher, 2001; Herrle, 2003). Research utilizing OAE1b sediment from additional locations is necessary in order to thoroughly understand the mechanisms that caused this global, ocean wide event.

There are two leading hypotheses for the cause of Cretaceous ocean anoxic events: intensified water column stratification (Erbacher, 2001; Herrle, 2003) and increased primary productivity (Erba, 1994; Erba and Larson, 1999).

Water column stratification has been hypothesized as the cause for OAE1b in the Vocontian Basin (Erbacher, 2001; Herrle, 2003). Stratification of the water column prevented oxygen-poor bottom waters from mixing with oxygen-rich surface waters (Erbacher, 2001; Herrle, 2003). The lack of oxygen in bottom and intermediate waters made these regions uninhabitable for most marine life. Without benthic and intermediate dwelling organisms, the marine system that functions to decompose organic material in intermediate waters broke down (Erbacher, 2001, Herrle, 2003). The unconsumed organic matter accumulated on the ocean floor, and was deposited as organic rich shale.

A significant increase in primary productivity has been hypothesized as the cause of OAE1a (Erba et al., 1994, Erba and Larson, 1999). An increased flux of nutrients to the world's ocean caused a dramatic elevation in primary productivity of phytoplankton (Erba, 1994; Erba and Larson, 1999). It has been hypothesized that accelerated plate movement, during the Mid-Cretaceous, increased the amount of nutrients in the ocean (Erba and Larson, 1999; Leckie et al., 2003). During the late Aptian/early Albian, formation of the Ontong Java Plateau was the primary catalyst for supplying additional nutrients to the marine realm (Erba and Larson, 1999). The additional nutrient flux originated from an increase in both submarine volcanism (Erba and Larson, 1999; Leckie et al., 2003) and continental runoff in an enhanced hydrologic cycle (Erba and Larson, 1999).

The additional nutrients served as fertilizer to phytoplankton, and resulted in a significant increase in the quantity of phytoplankton (Erba, 1994; Erba and Larson, 1999). Bacteria living in the intermediate water mass function to decompose the rain of dead surface dwelling organisms. In OAE1a, the massive quantity of phytoplankton descending into deep waters exceeded the capacity of middle water bacteria and benthic dwellers to consume the additional flux of organic matter to bottom waters. Organic matter accumulated on the ocean floor and was deposited as organic rich shale (Erba and Larson, 1999).

Surface water communities in OAE1b (Vocontian Basin) and OAE1a

Calcareous nannofossils provide a useful tool for determining productivity in surface waters. The level of primary productivity in surface waters will indicate whether oxygen depletion or an increase in productivity triggered OAE1b. The level of primary productivity in surface waters can be determined by monitoring changes in the abundance of both the calcareous nannofossil genus *Nannoconus* and species used as fertility indicators. The abundance of *Nannoconus* can be used to determine position of the nutricline (Erba, 1994); and the abundance of fertility indicators can be used to reconstruct nutrient content of surface waters.

Florisphaera profunda, a large and heavy nannofossil, thrive in low light and nutrient rich environments; therefore, is able to live at the base of the photic zone (Molfino and McIntyre, 1990). *Nannoconus*, an extinct genus, has been shown

to inhabit the same water column position as the extant species *Florisphaera profunda* (Erba, 1994). This similarity is significant because the abundance of *F. profunda* indicate depth of the nutricline.

The position of the nutricline control, in part, the amount of nutrients in surface waters. A high abundance of *F. profunda* indicates a deep nutricline and nutrient-poor surface water (Molfinio and McIntyre, 1990). Conversely, a lean abundance of *F. profunda* indicates a shallow nutricline and nutrient rich surface water (Molfinio and McIntyre, 1990).

Fertility indicators are nannofossil species that thrive in high or low nutrient environments. Nutrient levels in surface waters can be derived from the percent abundance of fertility indicators in a nannofossil paleocommunity. A high percentage of high fertility species indicate nutrient rich surface waters. A high percentage of low fertility species indicate nutrient poor surface waters.

Calcareous nannofossil paleocommunities contain significantly different fertility signatures in OAE1b, from the Vocontian Basin, and OAE1a. The fossil assemblage in OAE1b indicates low fertility in surface water. In OAE1a, the fossil assemblage indicates high fertility in surface water.

In OAE1b sediments, from the Vocontian Basin, *Nannoconus* increase in abundance, synchronous to a decrease in high fertility species (Herrle, 2003). The increase of *Nannoconus* reflects a deep position of the nutricline (Herrle, 2003), and the decrease of high fertility indicators indicates low productivity in surface water (Herrle, 2003). It has been hypothesized, based on this fossil assemblage, that productivity in surface waters was low during OAE1b.

The abundance of *Nannoconus* rapidly decreases, ~ 40,000 years, before OAE1a (Erba, 1994; Erba and Larson, 1999). *Nannoconus* remain nearly absent within OAE1a sediment (Erba, 1994). It has been hypothesized that the 'nannoconid crisis' (as termed by Erba, 1994) resulted from a sustained shallow position of the nutricline. The abundance of high fertility indicators increases significantly within the OAE1a interval (Erba, 1994). Primary productivity in surface waters was elevated significantly during OAE1a, as evidenced by the decrease in *Nannoconus*, indicating a shallow nutricline, and the dramatic increase in high fertility indicators, indicative of high fertility in surface water (Erba, 1994; Erba and Larson, 1999).

Research

OAE1b is splendidly preserved on the Blake Nose. The purpose of my research is to use the beautifully preserved sequences to reconstruct nutricline position and surface water productivity during deposition of OAE1b. This will be accomplished by deriving a percent abundance of calcareous nannofossil species in OAE 1b sediment. Structure of the surface water phytoplankton

community will be derived through a quantitative analysis of species most abundant in the fossil assemblage. Position of the nutricline will be determined by monitoring the abundance of *Nannoconus* (as derived in Erba, 1994). The amount of primary production in surface waters will be determined from the percent abundance of fertility indicators.

If stratification of the water column was the primary factor driving bottom water anoxia, then *Nannoconus* will increase in abundance, and high fertility species will decrease in abundance. If OAE1b resulted from an increase in primary productivity, then *Nannoconus* will decrease in abundance, and high fertility species should increase abundance.

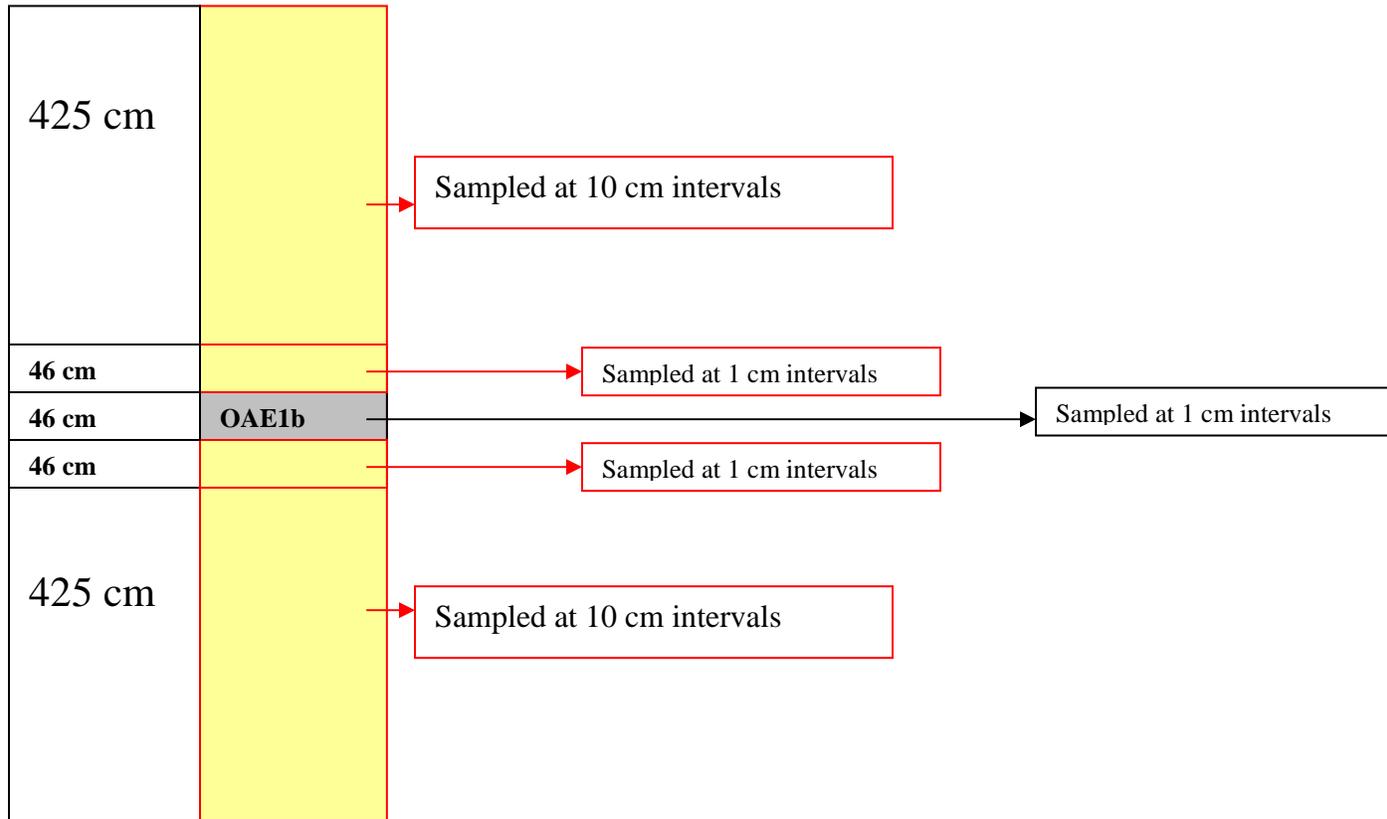
Methods

The core of my research involves counting the percent abundance of nanoplankton species in sediment from Leg 171B. Variation in the abundance of *Nannoconus* will be used to determine nutricline position before, during, and after deposition of OAE1b. The level of surface water productivity will be derived from a quantitative analysis of species that have been established in the literature as fertility indicators (*Biscutum ellipticum*, *Zeugrhabdotus erectus*, *Zeugrhabdotus embergeri*, *Watznaueria barnesae*, and *Discorhabdus ignotus*).

Approximately 10 meters of sediment will be studied. Sampling intervals will be broken down into five sections. Description of the sampling intervals can be seen in Figure 1. Sampling at 1 cm intervals will provide the high resolution necessary for observing changes in the surface water community immediately before, during, and after the OAE event. The 10 cm sampling intervals will allow observation of long term trends in the paleocommunity.

I will refine Aptian/Albian biostratigraphy by designating new species, splitting several marker taxa, and monitoring subtle shifts in species abundance. Biostratigraphic refinement derived from my research would most likely be useful in Gulf of Mexico biostratigraphy, given the close proximity of the Blake Nose.

Figure 1: Diagram of sampling technique for OAE1b, hole 1049c. The yellow and black column on the right represents core sediment. The column on the left represents the length of core that will be sampled. The yellow color indicates marl and chalk, and the grey color indicates the OAE1b black shale interval.



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