Norris, R.D., Kroon, D., Klaus, A., et al., 1998
Proceedings of the Ocean Drilling Program, Initial Reports, Vol. 171B

1. INTRODUCTION[1]

Shipboard Scientific Party[2]

The sediments on the Blake Plateau and the Blake Nose in the western North Atlantic Ocean offer an ideal record for reconstructing variability in Cretaceous and early Cenozoic deep-water circulation and sedimentation history, which are closely linked to climate change. Paleogene and Barremian–Maastrichtian strata crop out, or are shallowly buried, in present water depths of 1200 m to more than 2700 m across the plateau. The plateau spanned a similar range of depths during the early Cenozoic because margin subsidence was nearly complete by the Early Cretaceous, and minor subsidence since then has been partly offset by reduced sea level after the Eocene. Thus, a depth transect of cores along the paleoslope provides information on depth-dependent sedimentation, deep-ocean chemistry, and biota that can be used to reconstruct the past vertical structure and circulation of the western North Atlantic Ocean. In addition, data on the variability of Paleogene and Cretaceous fossil groups from the Blake Nose should make a significant contribution to the interpretation of their evolution in response to episodes of changes in deep-water circulation and bolide impact events.

The Cretaceous and Paleogene Blake Nose sediments span numerous events of paleoceanographic and biological significance, including short-term perturbations like the mid-Maastrichtian cooling, the Cretaceous–Paleogene extinction, the late Paleocene extinction, and the late Eocene impact horizons. There are also several long-term trends during the period such as the mid-Cretaceous anoxic events, the Aptian–Albian warm period, the Paleocene carbon isotope increase, the early Eocene warm period, and the middle to late Eocene cooling. These events, or trends, are associated with changes in the Earth's biota, biogeochemical cycling, and oceanographic circulation. Nonetheless, the records of many of the Cretaceous and Paleogene events are poorly dated and poorly understood because of their sparse representation in deep-sea cores or their occurrence at great burial depth. The sedimentary record on the Blake Nose has the combination of good microfossil preservation, unlithified sediments of great age exposed near the seafloor, and continuity of sedimentary packages across the slope that are needed to reconstruct a detailed history of the Paleogene and Cretaceous oceans.

DEPTH-TRANSECT STRATEGY

Recently, much attention has focused on reconstructing the Cenozoic history of deep-water chemistry and carbonate dissolution by drilling depth transects in the equatorial oceans. Transects have been drilled on the Walvis Ridge in the South Atlantic, the Ontong-Java Plateau in the Pacific, the Madinley Rise and the Oman Margin in the Indian Ocean, the Maud Rise in the Southern Ocean, and, most recently, the Ceara Rise in the equatorial Atlantic. The strategy behind drilling these transects is to determine bathymetric changes in carbonate preservation and to thereby infer the history of changes in lysocline depth, oceanic alkalinity, and surface-ocean carbonate production (e.g., Curry et al., 1990; Peterson et al., 1992; Berger et al., 1993). Transects that include sites at shallow depths also can be used to reconstruct changes in the sources of intermediate waters and to detect patterns of water-mass circulation (Curry and Lohmann, 1986; Slowey and Curry, 1987, 1992; Lynch-Stieglitz et al., 1994; Kennett and Stott, 1990). The origin of a water mass can be inferred both by measuring the characteristic δ^{13}C and Cd chemistry preserved in the shells of benthic foraminifers and by analyzing the faunal composition (Streeter and Shackleton, 1979; Boyle and Keigwin, 1982; Curry et al., 1988; Boyle, 1990; Charles and Fairbanks, 1992; Wright et al., 1992; Oppo and Rosenthal, 1994).

The Blake Nose transect extends over water depths between 1293 and 2586 meters below sea level (mbsl) for a total vertical range of 1293 m. This depth range spans the upper and lower boundaries of modern intermediate waters and Upper North Atlantic Deep Water; therefore, this transect is well located to monitor the vertical structure of intermediate waters in the Cretaceous and Paleogene as well as depth-related changes in sedimentation and benthic fauna. In addition, our sites can be compared with recent onshore coring by the United States Geological Survey to provide a total vertical depth range of nearly 3000 m and a horizontal transect of more than 320 km from the Carolina coast to the edge of the Blake Escarpment.

GEOPHYSICAL AND GEOLOGICAL BACKGROUND

The Blake Nose, or Blake Spur, is a salient on the eastern margin of the Blake Plateau, due east of the Florida–Georgia border (Figs. 1, 2). The Blake Plateau is mostly <1000 m deep, but drops sharply to water depths of >4000 m at the Blake Escarpment because of continental slope erosion. In contrast, the Blake Nose is a gentle ramp that reaches a maximum depth of about 2700 m at the Blake Escarpment. The Blake Plateau and the Blake Nose are each composed of an 8- to 12-km-thick sequence of Jurassic and Lower Cretaceous limestone that is capped by <1 km of Upper Cretaceous and Cenozoic deposits (Benson, Sheridan, et al., 1978).

Seismic records show the presence of buried reef buildups at the landward end of the Blake Nose (Figs. 2, 3 [back-pocket foldout, this volume], 4). Fore-reef deposits and pelagic oozes, built seaward of the reef front, rest on relatively flat-lying Neocomian–Barremian shallow-water carbonates and serve largely to define the present bathymetric gradient along the Blake Nose. Single-channel seismic (SCS) reflection data collected by the *Glomar Challenger* over Deep Sea Drilling Project (DSDP) Site 390 and more recent SCS and multichannel seismic (MCS) reflection data show that as much as 800 m of strata is present between the Campanian and Aptian reflectors updip of DSDP Site 390 (Hutchinson et al., 1995). Mid-Cretaceous to Barremian deposits form a series of major clinoforms that builds out from, and ultimately overlaps, the reef complex. A strong seismic reflector truncates these clinoforms. There may be two cycles of erosion within the clinoform stack, because those that overlap the reef complex downlap against underlying clinoform deposits.

The mid-Cretaceous sediments that make up most of the clinoform stack are black to green laminated claystones and sandstones. Deposits immediately below the Campanian at Site 390 are nanno-

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[1] Norris, R.D., Kroon, D., Klaus, A., et al., 1998. *Proc. ODP, Init. Repts.,* 171B: College Station, TX (Ocean Drilling Program).

[2] Shipboard Scientific Party is given in the list preceding the Table of Contents.

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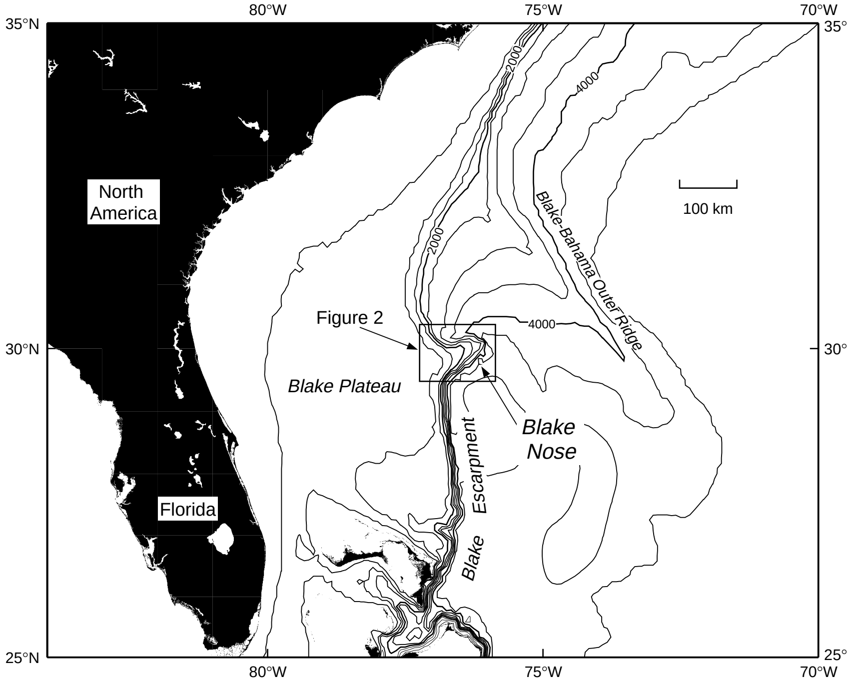

Figure 1. Location of the ODP Leg 171B Blake Nose paleoceanographic drilling transect.

fossil oozes and calcareous clays of Aptian–Albian age. The Aptian ooze at DSDP Site 390 can be traced updip in MCS Line TD-5 into the upper sequence of clinoforms (Fig. 3 [back-pocket foldout, this volume]). These clinoforms are successively cut into by the pre-Campanian to early Campanian erosion surface, which suggests that the remains of the top of the clinoform sequence have a progressively older age updip from DSDP Site 390. Drilling during Ocean Drilling Program (ODP) Leg 171B has shown this to be generally true, although a thin condensed sequence of Cenomanian to Turonian strata is present near the middle of the Blake Nose. DSDP Site 390 is about 60 km northeast of the pre-Barremian(?) reef front; therefore, the lower sequence of clinoforms may be redeposited periplatform deposits or reef-front debris.

A hiatus exists between the Albian–Cenomanian and the Campanian along most of the transect. Upper Cretaceous to middle Eocene carbonate oozes that rest on the Barremian reef-front deposits are typically <400–600 m thick and tend to thin toward the edges of the Blake Nose. This thinning is probably an original depositional feature because reflectors lap out near the Blake Escarpment on all three sides of the Blake Nose. There has been little deposition of sediments younger than the Eocene over much of the Blake Nose, as Eocene oozes are quite soupy at the location of DSDP Site 390. In addition, some erosion of the surface of the Blake Nose has truncated Eocene reflectors. As can be seen on MCS Line TD-5, the Eocene and Paleocene intervals are progressively truncated by erosion at the extreme western end of the Blake Nose, and the intervals also thin in this direction. A thin (<80 m) veneer of middle Miocene phosphatic marls rests on this erosion surface at the shallow end of the transect, and upper Eocene–Oligocene sediments also may be present in patches on the upper half of the Blake Nose. Other than these sediments, only a surficial layer, less than a few meters thick, of manganese-phosphorite nodules covers the Eocene ooze.

Sedimentation rates estimated from DSDP Site 390 are uniformly low (0.2–1.5 cm/k.y.). The highest rates are 1.5 cm/k.y. for the middle Eocene (Benson, Sheridan, et al., 1978). These low values almost certainly underestimate sedimentation rates on the shallower portions of the Blake Nose, where thicknesses of Aptian–Albian, Paleocene, and Eocene strata are much greater than those at DSDP Site 390.

Paleobathymetry

Shallow-water limestone of Barremian age with a foraminifer fauna that suggests depths of deposition of <50 mbsl was recovered at DSDP Site 390 (Benson, Sheridan, et al., 1978). Water depths increased substantially by the late Albian. Aptian–Albian pelagic oozes at the eastern end of the Blake Nose were probably deposited at >500 m water depth, based on ratios of planktonic and benthic foraminifers (Benson, Sheridan, et al., 1978). If we assume that the reef seen in seismic records at the western end of the Blake Nose was at sea level during the Albian–Aptian and that the depth gradient in the fore-reef deposits has not changed since that time, then the present difference in depth between the reef top and the seaward edge of the Blake Nose (~1500 m) probably reflects the greatest water depth at which the oozes were deposited on the Blake Nose during the Aptian–Albian interval. Upper Cretaceous and younger sediments were probably deposited somewhat below the present range of water depths (1100–2700 m; Benson, Sheridan, et al., 1978), given that the sea levels of those time periods are generally greater than present levels. The relative depth difference between sites, however, should have been nearly the same throughout the deposition of the Cenozoic and Upper Cretaceous sections. Consequently, once adjustments for sea level are taken into consideration, we should have unusually accurate estimates of paleowater depth for all the sediments we recover.

Scientific Objectives

The objectives of ODP Leg 171B were to drill shallow sites (170–600 m penetration) in a transect from the margin of the Blake Plateau to the edge of the Blake Escarpment. Our main interest was to interpret the vertical structure of the Paleogene oceans and to test the “Warm Saline Deep Water” hypothesis near the proposed source areas. A related objective was to provide critically needed low-latitude sediments for interpreting tropical sea-surface temperature by using well-preserved calcareous microfossils. We also hoped to investigate cyclicity in Paleogene and Cretaceous sediments that is a product of orbital cycles. This depth transect provides an excellent opportunity to recover sections through the Paleocene/Eocene and

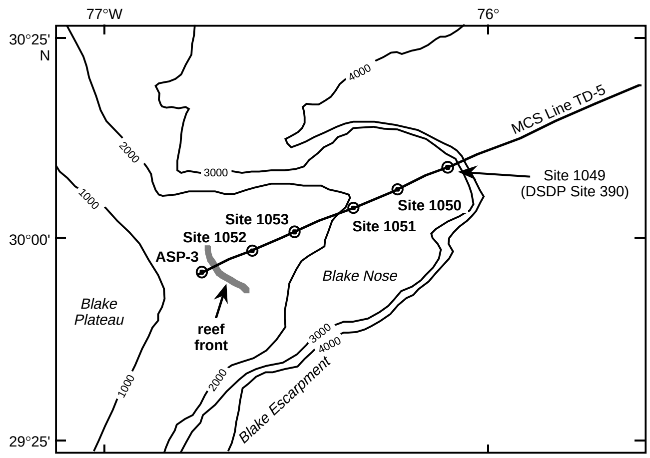

Figure 2. Map of the Blake Nose, located in the western North Atlantic Ocean, showing drilling sites and seismic line (see Fig. 3, back-pocket foldout, this volume). Bathymetry is in meters.

Cretaceous/Paleogene boundaries to document critical paleoceanographic and biological evolutionary events surrounding the boundaries as well as water depth–related variations in sedimentation of the boundary beds. Paleomagnetic objectives were to refine the biochronology and magnetochronology of the Paleogene–Cretaceous period and to constrain the position of the paleomagnetic poles for the North American Plate.

Paleogene and Cretaceous Deep-Water Circulation

The origin of deep waters exerts a fundamental control on biogeochemical cycles and global climate. Analysis of time periods in which deep-water formation and global temperature gradients may have been much different from well-known Pleistocene variability offers a test of the models developed to explain climate change. Oceanic circulation during the Paleogene and Cretaceous was quite different from that of the modern ocean, partially because of the greenhouse conditions that existed during part of that time and the apparent absence of major centers for deep-water formation in the northern basins. Many authors have suggested that deep-water circulation was enhanced in the Cretaceous and Paleogene by evaporation, which produced warm saline waters in marginal seas such as the basins of the Tethys and the epicontinental seaway of North America; however, there are few observational data to provide unequivocal support for this “Warm Saline Deep Water” hypothesis. The Blake Nose transect will be used to interpret the sea-level history and associated vertical structure of the Paleogene and Cretaceous oceans and to test the “Warm Saline Deep Water” hypothesis near the proposed source areas.

The deep waters of the world represent one of the largest reservoirs of nutrients and CO_2 in the biosphere. The history of deep-ocean circulation is integrally tied to the CO_2 storage capacity of the oceans and to the preservation of carbonate sediments in the deep sea (Farrell and Prell, 1991). Aging of deep water by remineralization of sinking organic material makes these waters extremely corrosive and gives them a major role in the variability of the inorganic carbon cycle by remineralizing carbonates that would otherwise be stored in sedimentary sequences. Hence, changes in the age and sources of deep waters regulate the alkalinity and CO_2 content of the deep sea.

Presently, deep waters are formed in the North Atlantic and Southern Oceans, and it is the mixture and aging of these water masses that produce the characteristic chemistries of the deep Indian and Pacific Oceans. The distribution of $\delta^{13}C$ in Paleogene benthic foraminifers suggests that most deep waters of this era have a southern source, but periods of weak latitudinal gradients and short episodes of anomalously warm deep water indicate that deep or intermediate waters may also have formed near the equator or in a northern area (Miller et al., 1987; Barrera and Huber, 1990; Stott and Kennett, 1990; Pak and Miller, 1992). Intermittent production of warm saline deep water may have continued in the Oligocene to middle Miocene in the remnants of the Tethys seaway (Woodruff and Savin, 1989). Alternatively, northern source waters may have formed throughout the Paleogene and Neogene, most probably in the North Atlantic (Wright et al., 1992; Corfield and Norris, 1996). The absence of a Paleogene or Cretaceous depth transect in the North Atlantic prevents resolution of this debate. The northern subtropical location of the Blake Plateau and its position adjacent to the western opening of the Tethys seaway would place it in the mixing zone between water masses of different origins during the Paleogene and Late Cretaceous.

The three-dimensional structure of Mesozoic and early Cenozoic oceans is of great interest because these oceans record climates and patterns of water-mass development under conditions different from those of modern seas. Examining deep-water history during periods with different boundary conditions will allow us to better appreciate the mechanisms that drive biogeochemical cycles. Studies of Paleogene and Cretaceous deep-water circulation and low-latitude climate are needed to understand the mechanisms that regulate the formation and geographic distribution of nutrient-rich deep waters in the modern oceans. An understanding of Paleogene and Cretaceous deep-water structure also is necessary to provide boundary conditions on global climate models (GCMs) and to test the assumptions used in models of the Quaternary oceans.

A depth transect in Cretaceous strata offers an unparalleled opportunity to study the hydrographic structure of the low-latitude Late Cretaceous oceans. DSDP Site 390, at the distal end of the Blake Nose, recovered a complete upper Campanian–Maastrichtian sequence. Evidence from numerous Southern Ocean sites suggests a major turnover of austral species at about 71 Ma in the Maastrichtian, which coincides with a major $\delta^{13}C$ excursion and extinction of inoceramid mollusks (Ehrendorfer, 1993; Macleod, 1994; Macleod and Huber, 1996). Low-latitude sites with good recovery and good preservation through this interval are rare, so it is still unclear whether the high-latitude turnovers are synchronous with low-latitude biotic crises. Preliminary data from Hole 390A suggest that the low-latitude ocean was affected by the mid-Maastrichtian reorganization of deep-water circulation. High-resolution records from a complete Maastrichtian sequence are needed to verify the faunal response to the mid-Maastrichtian deep-water reversal.

The Blake Nose depth transect should recover mid- to Upper Cretaceous sediments. Drilling at DSDP Site 390 recovered an Aptian–Albian sequence that is unconformable below the Campanian, but Santonian to Cenomanian sediments could be present upslope. We hope to use stable isotope ratios of benthic foraminifers for the mid- to Late Cretaceous period to determine the sources of deep waters when the North Atlantic was a relatively enclosed basin. The Aptian–Albian and Cenomanian–Turonian boundary intervals are particularly interesting because of the well-documented global phenomena of Oceanic Anoxic Events; however, the opportunity has never arisen to study these events across a depth transect, which may highlight the expansion of the oxygen minimum zones during these periods of sluggish bottom-water circulation.

Climate History and Low-Latitude, Sea-Surface Temperatures

The Eocene had the most equitable climate of the Cenozoic (Dawson et al., 1976; Shackleton and Boersma, 1981; Axelrod, 1984; Rea et al., 1990), and the Aptian–Albian was also a time of high sea-surface temperatures. Isotopic data suggest that both surface and deep waters reached their maximum temperatures in the early Eocene (Savin, 1977; Miller et al., 1987; and Stott and Kennett, 1990). High

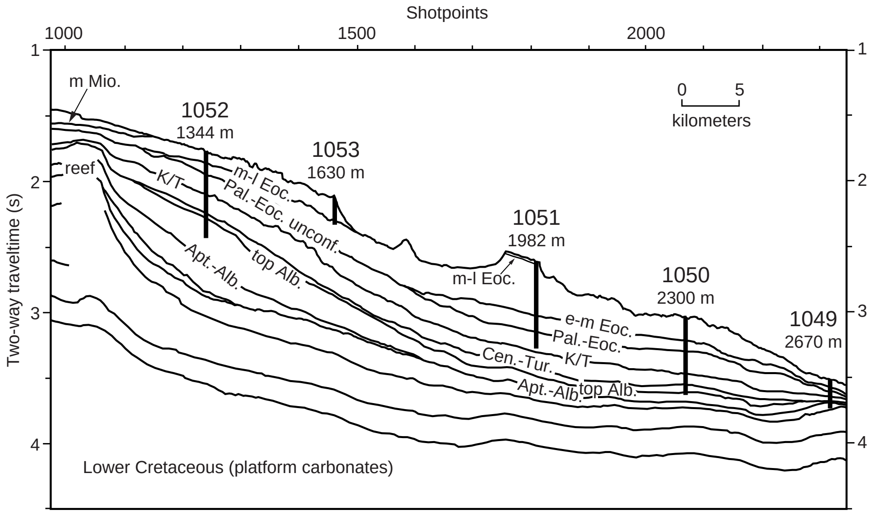

Figure 4. Schematic interpretation of MCS Line TD-5 showing major reflectors, their interpreted ages, and locations of Leg 171B sites.

latitudes were substantially warmer than at present and reached temperatures of 15°–17°C (Zachos et al., 1994). This warm interval lasted 3–4 m.y. and marked fundamentally different climate conditions than were present during any other time in the Cenozoic. Latitudinal thermal gradients were probably <6°–8°C during the Eocene, about one-half the modern pole-to-equator gradient (Zachos et al., 1994). Yet the interval is poorly known because low-latitude records are rare, and those that do exist are either intermittently cored or are disturbed by drilling through Eocene cherts (Stott and Zachos, 1991). The Aptian–Albian warm period is even more poorly known and has been studied primarily in outcrop sections from epicontinental platforms, where temperature estimates most likely do not reflect open-ocean conditions.

Estimates of global temperatures in the early Eocene and Aptian–Albian provide a means to test GCMs run under conditions of increased atmospheric CO_2 (Popp et al., 1989; Berner, 1990). Knowledge of low-latitude temperatures provides a major constraint on GCMs because equatorial seas play a major role in regulating heat exchange with the atmosphere (Barron and Washington, 1982). It is possible that the relatively warm Eocene climates were promoted by higher heat transport between latitudes (Covey and Barron, 1988). Hence, low-latitude temperature data are needed to constrain Paleogene and Cretaceous climate models. More generally, studies of warm intervals provide tests for climate models that integrate latitudinal thermal gradients, atmospheric CO_2 levels, and ocean-atmosphere heat transport.

The proxies we use to estimate past sea-surface temperatures may be seriously in error either because of diagenesis or biases imparted by surface ocean salinity. For example, Zachos et al. (1994) have suggested that relatively high salinity in Paleogene low-latitude oceans may partly account for the small equator-to-pole temperature gradients that are observed in compilations of planktonic foraminifer $\delta^{18}O$ data. Clearly, efforts are needed to assess the effects of diagenesis and biotic vital effects on the quality of sea-surface temperature estimates.

Late Paleocene Thermal Maximum

There is increasing evidence for a short-lived (100–200 k.y.) increase in global temperatures in the late Paleocene. The late Paleocene thermal maximum coincides with an abrupt extinction of benthic foraminifers and a marked excursion in the isotopic chemistry of both benthic and planktonic foraminifers. There is good evidence that production of Antarctic Deep Water may have been shut down at this time and that deep waters may have originated at low latitudes (Kennett and Stott, 1990; Pak and Miller, 1992).

Stable isotope evidence suggests that the latest Paleocene event was a brief exception to the general formation of deep waters adjacent to Antarctica (Miller et al., 1987). The Southern Ocean has consistently had some of the youngest waters found in the deep sea since at least the Late Cretaceous (Barrera and Huber, 1990, 1991; Pak and Miller, 1992; Zachos et al., 1992). However, the stable isotope data are strongly biased toward studies of high southern latitude cores and cannot eliminate the possibility of other sources of deep or intermediate water. Indeed, marked reductions in the $\delta^{13}C$ latitudinal gradient during the late Paleocene suggest that there may have been either extremely low rates of deep-water production or other sources of deep waters. Hence, drilling sites located near the ends of the Tethys seaway are needed to monitor the possible contribution of deep waters from the low latitudes and to monitor the biological effects of the latest Paleocene thermal maximum.

ODP Leg 171B drilling provided the opportunity to study the latest Paleocene extinction event at relatively low latitudes as well as the first continuous early Eocene Atlantic record of the benthic foraminifer repopulation after this extinction. Paleocene benthic foraminifer faunas were relatively uniform across a wide paleodepth, whereas Eocene assemblages were much more distinct at different depths. Depth-dependent changes in benthic foraminifer assemblages will provide critical data for interpretation of changes in the structure and sources of deep waters throughout the Paleogene.

Mesozoic and Paleogene Magnetic Records

The standard relative scaling of Upper Cretaceous–Miocene magnetic anomalies is derived from a spreading model for the South Atlantic Ocean (Cande and Kent, 1992, 1995). Correlations of micropaleontological datums with the associated polarity chrons form the framework of the current Paleocene–Miocene chronostratigraphic scale and assignment of absolute ages (e.g., Berggren et al., 1995a, 1995b). In contrast, the majority of the Campanian–Maastrichtian stages lack direct correlations of micropaleontologic or macrofossil datums with polarity chrons. Previous projections of ages of Campanian–Maastrichtian magnetic anomalies require major changes in spreading rates in the South Atlantic, near the Cretaceous/Paleogene boundary (e.g., Cande and Kent, 1992, 1995). Hence, a primary objective of ODP Leg 171B drilling was to refine the correlation between the magnetopolarity scale and biostratigraphic scales to improve the existing biochronology. A record of Milankovitch orbital cycles spanning known polarity zones will improve our estimate of spreading rates and age models of the Paleogene and Upper Cretaceous ocean basins.

Most current models of Cretaceous–Paleogene plate motion assume that North America remained stationary throughout most of the Cretaceous, but that this period of stability was preceded and followed by rapid spurts of continental drift (e.g., Irving et al., 1993). Rapid changes in the apparent rate of drift may be an artifact of poor age constraints from magnetically suitable sediments on the North American Plate. According to compilations of Cretaceous magnetic poles, the Blake Nose should have a paleolatitude of 30°N in the mid-Cretaceous (Hauterivian–Santonian), followed by rapid northward drift to a Campanian–Maastrichtian position near 40°N, and a return to the present latitude of 30°N in the late Cenozoic. The Blake Plateau is projected to have rotated counterclockwise ~20°–30° during this time. Because the Blake Plateau consists of a several-kilometer-thick pile of Jurassic–Cretaceous carbonates resting on the North American Plate, paleopole estimates from sediments in this area should provide a detailed profile of the directions, rates, and magnitude of North American Plate motion from the Aptian to the Eocene. In turn, these revised plate motions will place constraints on convergence rates of the Pacific Plate toward North America.

Paleogene and Cretaceous Evolutionary Dynamics

The Cretaceous and Paleogene periods record the rise of many modern groups of animals and plants as well as the extinction of others. Many major taxa were either completely removed during the end-Cretaceous extinction or were greatly reduced. Likewise, major extinctions and repopulations were associated with the Cenomanian/Turonian boundary, the late Paleocene thermal maximum, and the middle Eocene cooling trend. The evolutionary causes and effects of both the extinctions and repopulations are still relatively poorly known and vigorously debated. The questions surrounding many of the biotic turnover events revolve around issues of the extinction mechanism and the biotic/climatic controls over repopulation. For example, the terminal Cretaceous extinction is apparently associated with extremely rapid evolution of new taxa in many groups, followed by prolonged reoccupation of habitats that were vacated by the extinction episode.

Certainly, much of the problem involved in interpreting these profound biotic events lies in the rarity of detailed records of them, as well as the poor relative and absolute dating of their history. For example, the Cretaceous–Paleogene (K/T) extinction horizon is associated with condensed sections in many areas, and bioturbation has often distorted the sequence of events even in areas where sedimentation was approximately continuous across the boundary. Studying the events surrounding the boundaries in detail requires complete and expanded sections, which the Blake Nose sites have made available.

Sediments recovered at DSDP Site 390 contain extremely well-preserved microfossil fauna and flora, a prerequisite to studying their evolution in great detail. Our objectives were to investigate patterns of ecologic evolution through stable isotope, morphometric, and faunal analyses. Related to this effort is the study of the timing and origin of speciation events as a response to paleoceanographic history and impact events.

Cretaceous–Paleogene Event

Cretaceous/Paleogene (K/T) boundary beds are typically thin in the deep sea, yet they contain our best evidence for the geographic distribution and magnitude of the extinctions and the subsequent recovery of the biosphere.

Recent evidence for the impact of a bolide on the Yucatan Platform has focused debate over the history and consequences of this Cretaceous–Paleogene event. Evidence of an impact in the Gulf of Mexico includes discoveries of glass spherules and shocked quartz in boundary sections at Haiti and Mimbral, as well as gravity measurements and drill core data that imply the existence of a 180-km-diameter structure of Maastrichtian–earliest Paleocene age beneath the Yucatan Platform (Sigurdsson et al., 1991a, 1991b; Margolis et al., 1991; Alvarez et al., 1991; Hildebrand and Boynton, 1990). Reanalysis of DSDP Sites 536 and 540 in the Gulf of Mexico has led to the discovery of thick deposits of reworked carbonates of diverse ages. These deposits contain upper Maastrichtian nannofossils and occur immediately below lowest Paleocene sediments. Alvarez et al. (1991) have interpreted these K/T boundary deposits as part of the ejecta blanket.

Objectives of K/T boundary drilling on the Blake Plateau include the recovery of a detailed record of the events immediately following the impact, such as the sequence of ejecta fallout and settling of the dust cloud. DSDP Hole 390A contains foraminifer markers for the earliest Paleocene Pα Zone and the latest Maastrichtian nannofossil zones, suggesting that the section is biostratigraphically complete (Gradstein et al., 1978). Unfortunately, rotary drilling of this hole extensively mixed the soft ooze, making recovery of a detailed record of K/T boundary events impossible. Modern piston and extended core barrel coring technology produced much better recovery and less disturbed core during ODP Leg 171B than were obtained from DSDP Hole 390A.

Recovery of the boundary enables us to reconstruct the climatic and biological evolution immediately before the end-Cretaceous extinction and to evaluate the recovery of the oceans and biotas following the extinction. Piston-cored sections will provide evidence for the magnitude of the extinctions, their duration, and patterns of diversification following the event. Cores containing records of the lowermost Paleocene will also be suitable for studies of the geochemical history of the oceans in the absence of a diverse plankton community.

The Blake Nose depth transect certainly provides one of the best target locations to study depth-dependent patterns of sedimentation across the K/T boundary, the thickness of the tektite layer, and the effects of bioturbation. Our proposed drilling has penetrated the boundary section at present water depths of about 1410–2600 m, allowing us to determine whether there were depth-dependent changes in the carbonate lysocline or organic matter preservation after the extinction. The bathymetric transect also contributes to studies of depth-dependent changes in benthic foraminifer biofacies across the extinction boundary in a low-latitude setting.

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Ms 171BIR-101