March 27, 2005

IODP EXPEDITION 306: NORTH ATLANTIC CLIMATE 2
SITE U1312 SUMMARY

Hole U1312A Latitude: 42° 50.2040' N, Longitude: 23° 5.2506' W
Hole U1312B Latitude: 42° 50.2150' N, Longitude: 23° 5.2652' W
Water depth: 3522.1 mbsl

Site U1312 (Prospectus Site IRD4A) constitutes a reoccupation of DSDP Site 608 located NE of the Azores on the southern flank of the King's Trough tectonic complex in a water depth of 3554 m. Two principal holes (Holes 608 and 608A) were drilled to 515.4 mbsf and 146.4 mbsf, respectively, with the Variable Length Piston Coring System (VLHPC) and the Extended Core Barrel System (XCB) during Leg 94. Incomplete recovery and the present condition of the existing DSDP cores collected in 1983 do not permit the detailed paleoceanographic studies proposed here. The main objective at Site U1312 was to obtain continuous records of surface and deep-water characteristics and their interactions with ice-sheet instabilities during Neogene-Quaternary times. In this context, an important target at this site was the recovery of a complete undisturbed upper Miocene section by means of Advanced Piston Coring (APC).

Two holes were cored with the APC system and nonmagnetic core barrels at Site U1312. Hole U1312A was drilled to a maximum depth of 237.5 mbsf, with a recovery of 104.5%. At this hole, "drill over" technique was required for recovery of Cores 23H through 25H. Because of excessive heave (5+ meters), initial coring conditions were not optimum. This prevented the recovery of a good mudline in Hole U1312A, and the first several cores (1H through 3H, and 5H) were disturbed by flow-in. Hole U1312B was drilled to a maximum depth of 231.9 mbsf, with a recovery of 102.1%. In Hole U1312B, a successful mudline was achieved during a period of reduced heave, and "drill-over" technique was required only for the recovery of Core 25H. Drilling of a third hole was precluded as weather conditions dramatically deteriorated.

The Holocene to upper Miocene sedimentary succession at Site U1312 consists of varying mixtures of biogenic and detrital components, primarily nannofossils, foraminifers, and clay minerals. Based on sediment color, carbonate content, reflectance values, and the occurrence of detrital components, two lithological units were distinguished. Unit I (0-79.70 mbsf, Holocene to Late Pliocene) is dominated by nannofossil ooze, foraminifer nannofossil ooze, nannofossil ooze with (silty) clay, and (silty) clay nannofossil ooze. Alternating diffuse color bands occur throughout much of the unit. Most contacts between the various lithologies are gradational and/or bioturbated. Unit I was further subdivided into two subunits. Subunit IA exhibits high-amplitude variations in magnetic susceptibility and carbonate content whereas in Subunit IB these variations are less distinct. Dropstones are generally rare and small (2 – 15 mm in diameter), and they are concentrated in the upper 23 m of Subunit IA. Unit II (79.70-232.05 mbsf, Late Pliocene to late Miocene) is dominated by nannofossil ooze that exhibits little color change due to a downhole decrease in abundance of both detrital content and diffuse color bands.

Abundant, generally well-preserved calcareous nannofossils and planktonic foraminifers occur throughout both holes at Site U1312. Planktonic foraminifer assemblages are mainly composed of species that thrive today or are related to temperate- to subpolar-waters, with some sporadic incursions of polar-water and subtropical species. Nannofossil assemblages

consist of cosmopolitan species typical of the North Atlantic at mid-latitude. A reliable chronostratigraphic framework spanning from the late Miocene (~11 Ma) to the present was established based on the succession of bio-events identified in the cores. Linear sedimentation rates were estimated based on the depth of these events. Average sedimentation rates were low during the ate Miocene (1-2 cm/ky), increased in the Early Pliocene (3 - 8 cm/ky), and decreased again in the latest Pliocene and Pleistocene (about 1.5 cm/ky). Although calcareous plankton species were usually well preserved, intense fragmentation of planktonic foraminifer shells and overgrown discoasters were observed in the uppermost Miocene (161-171 mbsf in Hole U1312A and 165-175 mbsf in Hole U1312B), coinciding with an interval of very low sedimentation rates. The occurrence of a hiatus due to carbonate dissolution in this part of the record is probable, since several bioevents were observed in the same core. A similar interval with extremely low sedimentation rates and/or a possible hiatus but good carbonate preservation was also observed in the Late Pliocene-early Pleistocene (38 to 47 mbsf in Hole U1312A and 32 to 41 mbsf in Hole U1312B). Nannofossils recovered from this interval in Hole U1312B indicate an age older than planktonic foraminifers from the same horizon, further suggesting the presence of a hiatus or significant reworking.

Biostratigraphy based on siliceous fossils was hindered by rare occurrences and dissolution of radiolarians and diatoms. Trace numbers of diatoms are present in the upper ~60 m of both holes, and show an age-depth progression similar to the calcareous nannofossils. Below 60 mbsf, the sediments are almost entirely barren of diatoms. Likewise, radiolarians are found in trace numbers down to a depth of 85.5 mbsf in Hole U1312A, and 114 mbsf in Hole U1312B. Only one radiolarian event was observed in Hole U1312A, where as only samples at 28.5 and 37.5 mbsf contained rich radiolarian faunas in Hole U1312B.

The magnetic interpretations at Site U1312 were based on measurements of the natural remanent magnetization (NRM) after alternative field demagnetization at a peak field of 20 mT. The Brunhes/Matuyama reversal occurs at 18.40 mbsf in Hole U1312A, and at 16.95 mbsf in Hole U1312B. The Jaramillo Subchron occurs between 20.90 and 24.80 mbsf in Hole U1312B. In Hole U1312B, the Gauss/Matuyama and Gauss/Gilbert boundaries were tentatively placed at 51.60 and 72.2 mbsf, respectively, although a significant part of the Gauss interval (Chron C2An) is missing due to coring-induced sediment deformation. NRM intensities fall in the range of 10E-5 A/m between about 100 and 210 mbsf in both holes, which is close enough to the noise level of the magnetometer that establishing a continuous magnetostratigraphy was not possible by shipboard measurements. A long interval of normal polarity at the bottom of Holes U1312A and U1312B (top at 207.6 and 204.7 mbsf, respectively) was tentatively identified as Chron 5n.

Because only two holes were cored and because much of the upper portion of Hole U1312A was affected by coring disturbance, it was difficult to construct a complete splice for the entire sedimentary section. The remanent magnetic intensity following 20 mT AF demagnetization and the lightness parameter from color reflectance measurements proved to be the most useful for correlating between holes down to 158.89 mcd (the bottom of Core U1312B-16H). Below 158.89 mcd, stratigraphic correlation was difficult because of the very uniform sediment composition, resulting in few diagnostic variations in physical properties. From 158.89 up to 68.05 mcd, between-hole correlation was good and all core breaks could be filled, resulting in a complete splice. Above this, several gaps occur between core breaks and much of the spliced section is built from Hole U1312B cores, which contained virtually no coring deformation within this interval. From 0 to 40 mcd, lightness variations, which mainly reflect the carbonate content, mirror variations observed in the 0-1.5 Ma portion of benthic oxygen isotope stacks. Sedimentation rates derived from this correlation vary between 0.5 and 3.5 cm/ky over the past 1.5 Ma.

Carbonate concentration in the sedimentary record at Hole U1312A ranges from 59 to 98 wt% (average of 90.4 wt%). Highest values (92- 98 wt%) are observed in the lower part of the record (> ~55 mbsf), whereas the top ~55 m (lithological Subunit IA) are characterized by lower values and high variability. Two discrete intervals of lower $CaCO_3$ values (82 %wt) are present at 81.95 and 110.45 mbsf. A similar trend was observed in the overall $CaCO_3$ concentration at DSDP Site 608. Total organic carbon varies between 0 and 0.9 wt%, with the lowest values (0-0.1 wt%) found below 85 mbsf and higher, more variable values (0.1-0.9 wt%) above. Total nitrogen is low and relatively constant throughout the hole (around 0.1 wt%).

Pore water alkalinity in the upper 110 m exhibits a continuous trend in increasing values downhole to a depth of ~80 mbsf followed by a decrease thereafter. In contrast, chlorinity decreases with depth. The highest silica value of ~650 µM was measured at 53.5 mbsf. Barium exhibits its highest values (0.7µM) at 82 mbsf, just below the boundary between lithological Units I and II.

Physical property measurements at Site U1312 included non-destructive measurements of magnetic susceptibility, density and natural gamma radiation. Working sections were used to measure moisture and density (MAD) and compressional P-wave velocity. These properties generally show greatest variability in the upper 40 m consistent with greater clay content, and generally show lower values with depth, except for density and P-wave velocity, which increase with depth.

Site U1312 accomplished near full recovery of the excellent upper Miocene section first drilled at DSDP Site 608. The sedimentary sequence representing the last ~11 Ma will allow the study of short- and long-term climate variability and ocean/atmosphere interactions under very different boundary conditions, such as the closure and re-opening of Atlantic/Mediterranean connections at the end of the Miocene (6-5 Ma); the closing of the Isthmus of Panama (4.5-3 Ma); and the onset of major Northern Hemisphere glaciation near 2.5 Ma.