IODP Expedition 342: Paleogene Newfoundland Sediment Drifts

Week 2 Report (10-16 June 2012)

OPERATIONS

The vessel arrived at Site U1403 (proposed site JA-1A) at 1708 h (UTC-2.5 h) on 11 June 2012, after a 946 nautical mile transit from Site U1402. The transit speed averaged 12.6 nmi/hr but ranged up to 15.9 nmi/hr with Gulf Stream assistance. The local vessel time was advanced ½ hour to the Newfoundland time zone. After deploying the beacon at 1725 h, the drill string was assembled and prepared for operations. Hole U1403A (39°56.60'N, 51°48.20'W) was spudded at 1020 h on 12 June. The seafloor was initially calculated at 4955.7 mbrf (4944.3 m below sea level) based on a mudline core. However, this water depth was later suspected to be ~4 m too high, based on the seafloor depth for Hole U1403B and correlation with physical features found in Hole U1403B. The APC system recovered Cores U1403A-1H through 17H, where a hard layer was encountered at ~148 mbsf. The XCB system was deployed from Core U1403A-18X through 29X to a final depth of 253.3 mbsf. The seafloor was cleared at 1240 h on 14 June, ending Hole U1403A. Overall core recovery for Hole U1403A was 231.82 m for the 253.3 m interval cored (91% recovery). The total time spent on Hole U1395A was 67.5 hours.

The vessel was offset 20 m to the east. The bit was spaced out to 4954.5 mbrf in an attempt to recover ~8 m in the mudline core. The 3.9 m core recovery was a surprise. The seafloor depth was calculated to be 4960.1 mbrf (4948.7 m below sea level), which is 4.4 m deeper than recorded in Hole U1403A. This along with other indicators called into question the accuracy of the mud line core depth calculation in Hole U1403A. Hole U1403B was spudded at 1730 h on 14 June. The APC coring system was used for Cores U1403B-1H through 16H. The chert layer identified in the first hole was found to be exactly at the depth expected for Hole U1403B, confirming the initial error in water depth for Hole U1403A. The XCB system was deployed for Cores U1403B-17X through 18X, until we broke through the chert layers at 150.4 mbsf. The APC coring system was again deployed for Cores U1403B-19H through 22H to a depth of 175.9 mbsf. After a partial stroke on Core 22H that recovered 2.97 m, the XCB system was again deployed for Cores U1403B-23X through 32X to a final depth of 265.1 mbsf. Overall, core recovery for Hole U1403B was 229.81 m for the 265.1 m cored interval (87% recovery). At the conclusion of coring at 2200h on 16 June, the hole was swept clean with 30 barrels of high viscosity mud and the drill string was raised up to to 78.43 mbsf for logging with the triple combo string and FMS-Sonic-NGR string.

SCIENCE RESULTS

Site U1403 (proposed site JA-01) is the first and the deepest water site to be drilled on the J Anomaly Ridge, pinning the deep end of the Paleogene Newfoundland sediment drifts depth transect. The site is positioned to capture deep excursions of the calcite compensation depth (CCD) during the Paleogene and to help improve stratigraphic control on the sediments to be drilled on J Anomaly Ridge.

The downhole sedimentary progression at Site U1403 reveals a diversity of deep-sea pelagic sediments comprising foraminifer sandy clay, unfossiliferous clay, red, brown, and black chert, clay with radiolarians, clay with nannofossils and radiolarians, nannofossil ooze and chalk. Surficial sediments include foraminifer sand with manganese nodules that overly a succession of unfossiliferous clay, and clay with nannofossils and radiolarians. Chert is present below 150 m between intervals of radiolarian clay and nannofossil ooze and chalk. Cherty intervals are typically poorly recovered while intervening recovered intervals include the Early Eocene Thermal Maximum 2 ("ELMO"), the Paleocene-Eocene Thermal Maximum (PETM), and the Cretaceous-Paleogene (K/Pg) boundary. A thin, graded, green spherule horizon is present at the K/Pg boundary and interpreted as debris from the Chicxulub impact event. Underlying sediments largely consist of color banded nannofossil chalk to a depth of ~262 m.

The sediments recovered at Site U1403 are Pleistocene to Campanian in age. Quaternary nannofossils and planktonic foraminifers are present in the uppermost 2 m of the section, but from 2 to 70 m the sediments contain no age-diagnostic fossils. Nannofossils and radiolarians indicate a middle Eocene (44.5 Ma) and lower Eocene to K/Pg boundary sequence from ~70 to 220 m. Preliminary biostratigraphic analysis suggests that there may be minor hiatuses in the lower Eocene and middle-upper Paleocene. Fossiliferous sequences of both the PETM and ETM-2 hyperthermal events were recovered and include "excursion" nannofossil assemblages. The K/Pg boundary section appears to be biostratigraphically complete. A high diversity uppermost Maastrichtian nannofossil assemblage occurs below the K/Pg impact ejecta bed and very low diversity, post-mass-extinction assemblages occurs above this bed. These earliest Danian assemblages are dominated by calcareous dinoflagellates and a handful of Cretaceous nannofossil survivor species, and are followed up-section by a record of nannoplankton recovery and diversification. Hole U1403B bottomed at ~262 m in upper Campanian sediments consisting largely of nannofossil chalk. Planktonic foraminifera are absent or very poorly preserved through most of the succession, except for an interval of well-preserved assemblages in the lowermost Danian and uppermost Maastrichtian. Benthic foraminiferal assemblages characterized by agglutinated species, and sporadic occurrence of calcareous taxa, are present throughout the Paleocene to Cretaceous. Planktonic foraminifera are mainly restricted to the basal Danian and the Maastrichtian.

Paleomagnetic data reveal a sequence of possible reversals below ~60 m in Hole U1403A. Non-magnetic core barrels were used during APC coring at Site U1403 but a strong vertical overprint is persistent in most cores even after 20mT demagnetization. Reductive dissolution and the absence of age-diagnostic fossils are additional issues that make the identification of magnetozones difficult, particularly between Cores U1403A-2H and -5H. Core orientations provided by the FlexIt tool system, as well as demagnetization data from discrete samples, substantially help clarify the identification of polarity transitions. XCB coring obscured the declination record of polarity reversals, as anticipated, but the inclination component after 20 mT demagnetization seems to be useful for recognizing

some magnetozones. Bulk susceptibility of discrete samples shows similar 1° and 2° cycles as those observed in the whole round magnetic susceptibility measurements.

A partially spliced composite depth record was produced for Holes U1403A and U1403B. The mudlines could not be reliably aligned owing to an inconsistency in the apparent seafloor depths between the two holes. However, based on real time analysis of density and magnetic susceptibility data, the drillers were directed to pull up twice before taking Cores U1403B-3H and 4H and this resulted in a good offset between between successive cores in Holes U1403A and U1403B between ~20 and 150 m CCSF (core composite depth below seafloor). Below 150 m CCSF, where chert layers were encountered in both holes, floating composite sections for the ELMO, PETM, and the K/Pg boundary were constructed.

Age-depth relationships are based largely upon biostratigraphic datums for radiolarians and calcareous nannofossils in Hole U1403A. The upper ~80 m of the sediment column at Site U1403 is undated other than an ~2 m-thick layer of Pleistocene sediment. The first dated record below this barren interval is a 40.65 Ma radiolarian datum at 82 m CSF-A. Average linear rates of sedimentation of ~0.6 cm/ky are relatively stable to ~148 m CSF-A. Between 148 and 149 CSF-A, an ~three million year-long interval from 50.5 to 53.7 Ma is recorded by a series of chert horizons. The lower Eocene to the PETM sequence accumulated at average linear sedimentation rates of ~1.4 cm/kyr. Immediately underlying the PETM, a highly condensed chert-rich interval comprising at least one hiatus between 182 and 189 m CSF-A corresponds to ~56-62 Ma. Average linear sedimentation rates of ~0.8 cm/ky are recorded in the interval spanning the K/Pg boundary (~62-69 Ma).

Headspace gas, interstitial water (IW) and bulk elemental analyses (IC, TOC, TC and TN) have been routinely carried out for Hole U1403A. The sampling resolution was one sample per core for headspace gas, typically one sample per core for IW analysis, and one sample per section for sediment analysis. Additional sediment samples for carbonate analysis were collected from the PETM, ETM2, and K-Pg transition sediments to conduct higher resolution analysis (one sample per 20 cm). In headspace gas analysis for the purpose of safety monitoring, methane was detected in low concentration and gradually increased to 17 ppmv with depth. Other higher hydrocarbon gases were not detected. TOC content was quite low in the upper 34 m in Hole U1403A, ranging from 0.14 to 0.46 wt %, except for the interval 27-31 m where TOC content ranged from 1.4 to 1.7 wt%. Carbonate content varied between 0.04 and 0.80 wt% in Cores U1403A-1H to 13H. In the bottom of Core U1403A-13H (~137 m) carbonate increases to 60% and fluctuates between about 2 and 40% to the bottom of the recovered sequence.

Physical property data show downhole variations in sediment color, bulk density, magnetic susceptibility and P-wave velocity. Discrete measurements of bulk density focused on Hole U1403A. Thermal conductivity was not measured owing to unresolved problems with the instrument's sensitivity to the environment. The uppermost 20 m of sediments recovered at Site U1403 are brown in color with high magnetic susceptibility (80-20 instrument units [IU]) and moderate to low bulk density (1.5 g/cm^3). Between

20~130 m, sediments are green, blue or brown with low to moderate bulk density (1.1-1.5 g/cm^3) and average magnetic susceptibility of ~20-30 IU. A transition into pink and tan sediments occurs at 130-140 m, an interval in which carbonate and biogenic silica both make an appearance. Another step in P-wave velocity (from 1500 to 1600 m/s) occurs below 160 m. This transition is also reflected by increases in magnetic susceptibility and bulk density. Below 160 m, bulk density gradually increases from 1.7 to 1.9 g/cm^3, magnetic susceptibility shows fluctuations between 20-140 IU, and color ranges from pale green, reddish brown to pale brown. A step increase in P-wave velocity occurs at ~220 m. Color and magnetic susceptibility cycles are evident in parts of the record that may reflect various orbital periods.

EDUCATION AND OUTREACH

The highlight of week two in the vigorous Expedition 342 education and outreach program was the posting of Dan Brinkhuis' Expedition 342: Departure video on the Ocean Leadership YouTube page. It has been viewed over 650 times in just three days. Departure introduces Expedition 342 to the public and includes the first installments of "Titanic Tales" with Richard Norris and "Eocene Invasion" with Caitlin Scully and her cohort of Eocene stuffed animals. Currently there is a naming contest for the Eocene mammals running on Facebook. We continue to post stories and pictures on JR.org, Facebook, Twitter, and tumblr. Seven new blog entries were posted on JR. org including a new Q&A interview format, which was the most popular post this week. We had three Ship-to-Shore broadcasts: Palmerton, New Zealand, and Pittsburg, USA (2). Shipboard scientists across a wide spectrum of career stages, scientific specialties and nationalities (Diederik Liebrand, Sandy Kirtland Turner, Chris Hollis, and Pincelli Hull) fielded student questions.

TECHNICAL SUPPORT AND HSE ACTIVITIES

The technical staff supported core processing and shipboard laboratory activities.
A fire drill was held on Tuesday, 12 June.