IODP Expedition 342: Paleogene Newfoundland Sediment Drifts

Week 3 Report (17-23 June 2012)

OPERATIONS

Week 3 of Expedition 342 (Paleogene Newfoundland Sediment Drifts) began while making up the triple combo logging tool string in the rotary table. The first logging run reached the bottom hole assembly (BHA) and was unable to pass through it. After trying unsuccessfully to get the logging tools to pass the BHA, the tools were returned to surface and examined to determine why this occurred. After making some corrections to the wireline tools, the tools were again deployed at 0710 h on 17 June and again failed to pass through the BHA. This time the tools became firmly stuck inside the BHA with ~17 m of the logging tool string extending out from the bit. After working the tools for several hours with no progress, a Kinley crimp was set on the wireline above the tool to prevent the tool from falling out while pulling out of the hole. The logging wireline was severed at 1830 h on 17 June using the Kinley cutter and retrieved and spooled back onto the winch drum.

After recovering the wireline, the drill string was pulled from the hole. Prior to pulling clear of the seafloor, the space out was carefully calculated, which should have resulted in the bottom of the Schlumberger tool string being at least 5 m above seafloor when the pipe was set down on the dual elevator stool. Then we began retrieving the drill string. When we had only ~117 m of the BHA remaining to be recovered, the end of the Schlumberger wireline was found and the logging tool string was freed from the BHA and rigged down on the drill floor. It was at this time that we discovered that the triple combo tool string had parted at the lower (MC) centralizer – ~17 m of logging tools were missing from the bottom of the tool string, including the density and porosity tools. When the bit cleared the rig floor, inspection revealed that there was manganese nodules lodged between the roller bit cones, along with other typical seafloor sediments. We speculate that when the bottom of BHA (drill bit) cleared the seafloor, the high bottom current experienced since first coming onto site had caused the BHA to shift laterally while part of the logging tool string extending past the bit remained in the hole. A close examination of the tool failure appears to substantiate this theory.

With the loss of the tool and the limited evidence at hand, a seafloor survey of the area surrounding the well bore was scheduled to determine if the tool was located on the seafloor. The search grid was defined to cover a square with 100 m sides and centered over Hole U1403B. While the drill string was tripped towards the seafloor, the subsea camera system was readied for deployment. A grapple was attached to the underside of the camera frame so that we could make an attempt to retrieve the lost part of the logging tool string. Although there was concern that the additional >700 pounds of logging tools could be lifted with the camera winch in 5000 m of water, it was felt the winch, in combination with the drill string, could be used to lift the tools towards the surface. The VIT frame is designed so that it can't pass over the bit at the end of the drill string.

After tripping the drill string to 3499 mbrf, the rig was secured at 1645 h on 18 June. The camera system was then installed around the drill pipe in the moon pool. This routine task generally takes 30 minutes. However, the lower guide horn could not be opened because the ocean current on location was pushing the pipe all the way to the side of the lower guide horn. Eventually the ship was moved up-current and using a combination of drift and maneuvering down current, the drill pipe was centralized in the moon pool, allowing the moon pool doors to be opened. After the doors were opened and the camera system was deployed to 100 mbrf, the doors were closed and the upper guide horn was replaced. It took almost 2.5 h to accomplish this task. We continued tripping the drill string to bottom while also lowering the camera system. During the entire camera run, the camera was shaking, vibrating and rotating around the pipe at different depths. At 2145 h, with the bit ~30 m from the seafloor, the signal from the camera system was lost and the Mesotech Sonar, which is also mounted on the VIT frame, failed as well. While pulling the camera to surface the winch operator noticed that the effort required to retrieve the camera system was much less than normal for the water depth. The suspicion that the co-axial cable supporting the camera system had failed was confirmed when the camera cable was pulled to the surface without the camera system attached.

At this point our only option was to retrieve the drill string and to recover the camera system that we hoped had landed at the bit. Preliminary estimates for the time to repair the camera system were 24-48 hours. We determined that another attempt to retrieve the failed part of the logging tool string would likely result in another failure of the camera system. The violent nature of the ocean currents on the camera system resulted in two separate failures during the first deployment. We nearly lost the only camera system IODP has available to conduct reentries for the program. Further attempts could have resulted in the complete loss of our re-entry system that is critical to our on-going operations.

We no longer had the ability to conduct an adequate bottom survey to attempt to locate the broken part of the logging tool string. The drill string with the damaged camera system was recovered at approximately 1400 h on 19 June. The drill floor was secured at 1415 h ending Site U1403 (JA-1A) and Hole U1403B. The vessel then proceeded underway to Site U1404 (JA-13A). The total time spent on Hole U1403B was 121.5 hours.

After a 4.2 nmi transit to Site U1404 (JA-13A) averaging 5.3 nmi/hr, the vessel stabilized over Site U1404 at 1455 h (UTC-2.5h) on 19 June. The drill pipe was deployed to 4684 mbrf and the drill bit was spaced out to 4715 mbrf for the first attempt at a mudline core. The calculated depth from the Precision Depth Recorder (PDR) was 4718.4 mbrf. A mistake in the pipe tally resulted in several attempts at recovering the mudline, which was eventually established at 4753.8 mbrf, 35.4 m below the PDR depth. Hole U1404A was spudded at 1030 h on 20 June with a 4.7 m long mudline core. We suspect that the strong currents are putting an S-shape into the drill pipe, which is making our measured length to the seafloor actually longer than our sonar calculated PDR length depth. Non-magnetic core barrels were used for Cores U1404A-1H through 32H. Core orientation was performed with the FLEXIT tool on Cores U1404A-1H through 23H but not deeper because of concerns over the risk pressure casing failure during partial APC advance and the possible consequences for drilling operations. At Core U1404A-22H the formation began to firm up and the first partial stroke was recorded. All cores from U1404A-22H through 32H were partial strokes and the hole was advanced by recovery. Total advance with the APC system was 271.0 m. The XCB system was deployed for Cores U1404A-33X through 36X to the final depth of 308.8 m. The drill string was pulled from the hole and the seafloor was cleared at 2040 h on 22 June 22, ending Hole U1404A. Overall core recovery for Hole U1404A was 281.02 m for the 308.8 m interval cored (91%). An unusually low recovery for APC operations was largely attributable to ongoing problems with collapsing core liners. Often, crumbled core liners needed to be pumped out of the core barrels; supplies of the seals required to accomplish that are running low. The total time spent on Hole U1404A was 77.75 hours.

After clearing the seafloor, the vessel was offset 20 m to the east. The bit was spaced out to 4752.0 mbrf in an attempt to recover ~8 m in the mudline core. The 2.48 m core recovery was not really a surprise, considering the problems that were encountered with the mudline in Hole U1404A. The seafloor depth was calculated to be 4759.1 mbrf (4747.6 mbsl). Hole U1404B was spudded at 2255h on 22 June. At week's end, APC coring had advanced to 184.1 m with Core U1404B-21H, with 182.8 m of core recovered from a cored interval of 184.1 m (99%).

SCIENCE RESULTS

Site U1404 (proposed site JA-13A) is the second deepest water site to be drilled on the J Anomaly Ridge and together with Site U1403, pins 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 sequence at Site U1404A reveals three lithostratigraphic units. The upper 12 m are Holocene-Pleistocene brown foraminifer-sandy clays with notable manganese nodules and a cobble-sized dolomitic dropstone, transitioning to Pliocene brown clay with silt. Green and greenish-gray carbonate-poor clay occurs in a nearly 200 m-thick sequence and contains abundant diatoms, radiolarians and sponge spicules. A thin interval of carbonate-rich nannofossil ooze marks a record of the earliest Oligocene and uppermost Eocene and overlies 75 m of clay and claystone with radiolarians and rare calcareous nannofossils. Lithoclasts are found in the >63 μm size fraction in Site U1404 sediments, particularly in the Miocene and Oligocene portions of the record. A prominent blue-grey bed, associated with a distinctive spike on natural gamma radiation, may represent the Chesapeake Bay impact ejecta blanket in the upper Eocene record of Hole U1404A.

Site U1404 recovered a lower Miocene (~19 Ma) to middle Eocene (~43 Ma) succession with a thin (~2.5 m), Pliocene-Pleistocene cover. Miocene sediments are represented by well-preserved benthic foraminifer assemblages and abundant diatoms—both characteristic of high organic matter flux and seafloor oxygen consumption. Radiolarians, nannofossils and planktic foraminifers provide biostratigraphic control in the Miocene and Oligocene. An Oligocene/Eocene boundary interval appears to be stratigraphically complete with variable carbonate content, and relatively good preservation of calcareous nannofossils, radiolarians, and benthic foraminifera. A succession of nannofossil events that characterizes the Eocene-Oligocene transition globally is also recorded here, including the extinction of the multiradiate discoasters and the Clausicoccus acme. The stratigraphic succession at Site U1404 extends at least into the middle Eocene but the lowermost cores are barren of all fossil groups.

Paleomagnetic work involved routine demagnetization measurements on archive section halves from Holes U1403B, U1404A, and approximately one-third of those from Hole U1404B, as well as measurements of AMS and demagnetization behavior on discrete samples from Holes U1403B and U1404A. Highlights from Site U1403 Report center on our identification of a complete series of magnetozones that can be correlated to Chrons 16n.1r to C22r (35.892-49.344 Ma), which provides a precise chronologic framework for clay-rich and fossil-poor lithologic Units II and III at Site U1403. Our age model has also dated a lithologically distinct horizon in Sections U1403A-6H-2 and U1403-6H-5 to within Chron C16n.1n (35.706-35.892 Ma), suggesting that this horizon may mark the Chesapeake Bay Impact event. A similar lithologic event has been recognized in Hole U1404A, suggesting a possible tie in that site's magnetochronology. Pass-through magnetometer studies in Hole U1404A suggest a partial sequence of magnetochrons that can be tested with analysis of discrete samples.

A complete splice has been identified at Site U1403, down to ~160 m composite core depth below seafloor (CCSF). From that point eight intervals were appended as part of the floating splice separated by intervals of unrecovered section. Chert layers prevented recovery between the unbridgeable core gaps of the floating part of the splice. Splices span relatively continuous intervals of the Pleistocene to early Miocene, ETM2 to PETM and early Danian to Campanian (including K-Pg boundary). The physical properties signals in Site U1404 sediments are not well suited to generating a well-resolved splice between holes in real time for the purpose of monitoring and directing drilling operations. Magnetic susceptibility records show generally no variability in the upper 200 m core depth below seafloor (CSF-A), and the GRA-density record shows a distinctive long-term trend but little in the way of distinctive core-to-core variability. At this time, a considerable uncertainty remains over our attempts to bridge core gaps in Hole U1404A with recovery in Hole U1404B. Analysis of further physical properties data sets will help resolve this uncertainty.

Preliminary biostratigraphic analyses suggest continuous, lower Miocene-upper Oligocene and upper-middle Eocene intervals with comparatively high average linear sedimentation rates (1.8 and 1.1 cm/ky, respectively) for such a deep-water site, and an Oligocene to Eocene/Oligocene transition with a lower sedimentation rate (0.5 cm/ky). A minor hiatus is present in the lower Oligocene (~33-32 Ma).

Physical properties data series at Site U1403 reveal some striking features. Magnetic susceptibility shows peaks at major events: the ETM-2 transition at ~160 m CSF-A, the

PETM at 177 m in Hole U1403A, and 183 m CSF-A in Hole U1403B, an event in the Paleocene around 190 m CSF-A and the K-Pg boundary at ~220 m CSF-A. Color reflectance parameters increase in nannofossil-dominated sediments, above 130 m CSF-A. P-wave velocity and bulk density clearly increase around 150 m CSF-A with higher carbonate content. Water content and porosity decrease at the depth.

Physical properties measurements at Site U1404 reveal an abrupt drop in magnetic susceptibility, natural gamma radiation and color reflectance at ~15 m CSF-A. Bulk density decreases from 1.30–1.55 to 1.21–1.40 g/cm^3 and water content and porosity increase from 45%–65% to 60%–70% and from 70%-80%, respectively between 20 to 30 m CSF-A. We also encountered bubbling cores with cottage-cheese texture when they were split in Section U1404B-4H-1, suggesting the presence of gas hydrate. Between 30-192 m CSF-A, magnetic susceptibility and bulk density are both very low, but both properties shift to higher values in carbonate sediments associated with the Eocene-Oligocene transition.

Bulk weight percent carbonate concentrations were determined for the remainder of sediment samples from Hole U1403A. Carbonate concentrations range between 0.0 to 86.3 wt% and variations in carbonate concentrations correspond to lithostratigraphic changes. In lithological Units II and III, carbonate concentrations were low (<1 wt%), below which (120 m CSF-A) concentrations are variable, ranging from 0 to 62.3 wt% in Cores U1404A-14H through 16H. High-resolution carbonate records across the PETM (182 m CSF-A) reflect an abrupt transition from <0.5 to >30.0 wt%. The K-Pg boundary transition (~220 m CSF-A) is marked by multiple (~30%) oscillations in carbonate followed by a sharp decrease in carbonate (~217 m CSF-A).

For Hole U1404A, headspace gas, interstitial water (IW) and bulk elemental analyses (IC, TOC, TC and TN) were performed routinely. The sampling resolution was typically one sample per core for headspace gas and IW analysis and one sample per section for sediment analysis. Additional sediment samples for carbonate samples were collected from the E-O boundary aged sediments (Sections U1403A-23H-1 through 24H-4) to perform a higher resolution analysis (one sample per 20 cm). Headspace gas analysis reveals gradually increasing downhole trends in methane (1.69 to 28.76 ppmv) and ethane (0 to 2.14 ppmv) concentrations. To date, carbonate analysis was conducted for sediments collected from Cores U1404A-1H through 11H (0.38 to 220.4 m CSF-A). Calcium carbonate content above 48.8 m CSF-A is relatively low, ranging from 0.18 to 0.78 wt%, but fluctuates to a maximum of 57 wt% at 202.7 m CSF-A (the transition from the Eocene to the Oligocene). The “acidification method” of total organic carbon is currently being applied to a preliminary suite of samples in an attempt to improve analytical precision in high $CaCO_3$-low-TOC-sediments. The hypothesized presence of gas hydrates in sediments recovered at Site U1404 will be tested using pore-water geochemistry.

An attempt was made to log Hole U1403B to provide continuous physical properties data to splice the incomplete coring records of Holes U1403A and U1403B. The failure of this attempt is described in detail in the Operations section. No useful logging data were returned, and the loss of part of the logging string caused a significant delay in occupying Site U1404 because of the need to trip pipe to attempt to extract the logging tool and then again to search for the missing component of the tool string.

EDUCATION AND OUTREACH

Our video, "Expedition 342: Departure", reached over 1000 views in less than one week. Dan Brinkhuis has been busy working on the second installment, "Core on Deck" that describes the first few weeks onboard the JR and features Peter Lippert and Brian Romans (Paleomagnetism and Sedimentology laboratories, respectively) We continue to post stories and pictures on JR.org, Facebook, Twitter, and tumblr. There were five blog entries posted this week. The tumblr page has been growing slowly but surely and now has 50 followers. The Facebook contest for naming the "Eocene Invasion" mammals was a success and there were numerous submissions. There was one Ship-to-Shore broadcast this week—high school students from Lower Hutt, New Zealand spoke with Chris Hollis.

TECHNICAL SUPPORT AND HSE ACTIVITIES

The shipboard labs were busy processing cores. A box was fabricated for the thermal conductivity instrument in an attempt to shield the measurements from adverse effects of the varying lab environment. Regulators were replaced in the gas distribution system in the pallet storeroom. A fire and boat drill was held on Thursday, 21 June.