IODP Expedition 342: Paleogene Newfoundland Sediment Drifts

Week 4 Report (24-30 June 2012)

OPERATIONS

Week 4 of Expedition 342 began with the completion of Hole U1404B (Cores U1404B-22H through 27H), to a depth of 228.7 m driller's depth below seafloor (DSF), at 1200 h on 24 June. Cores U1404B-21H through 27H were all partial strokes as the formation began to firm up. A total of eight core liners were either collapsed or broken and three of those had to be pumped out of the core barrel with a high-pressure pump. The bit cleared the seafloor at 1310 h on 24 June, ending Hole U1404B. A total of 27 piston cores were taken over a 228.7-m interval, with a total recovery of 228.04 m (100%). The total time spent on Hole U1404B was 40.5 hours.

The vessel was offset 20 m to the south and Hole U1404C was spudded at 1445 h on 24 June and drilled without coring to a depth of 16 m, based on the seafloor depth from Hole U1404B (4759.1 mbrf; 4747.6 m water depth). Cores U1404C-2H through 4H were recovered to a final depth of 44.5 m. A total of 28.98 m were recovered (102%). The bit cleared the seafloor at 1945 h on 24 June, ending Hole U1404C. The total time spent on Hole U1404C was 6.5 hours.

The drill floor was secured and the vessel moved to the next site, Site U1405 (proposed site JA-14A), in dynamic positioning (DP) mode at a speed of 0.8 nmi/hr. Cores U1405A-1H through 26H were recovered to a depth of 241.9 m DSF using non-magnetic core barrels and the FLEXIT core orientation tool. Advanced Piston Corer Temperature (APCT3) measurements were taken on Cores U1405A-4H, 7H and 10H with good results. Core U1405A-26H experienced the first partial stroke and the liner and core had to be pumped out of the core barrel. The XCB system was deployed for Cores U1405A-27X through 33X to a final depth of 308.6 m DSF. Overall core recovery for Hole U1405A was 270.34 m for the 308.6 m interval cored (88% recovery). The seafloor was cleared at 1120 h on 27 June, ending Hole U1405A. Total time spent on Hole U1405A was 51.50 hours.

The vessel was offset 20 m to the east. The bit was spaced out to 4296.0 mbrf in an attempt to recover ~8 m on the mud line core. Hole U1405B was spudded at 1305 h on 27 June. Based on the 9.5-m (full barrel) recovery, the seafloor depth was determined to be 4296.0 mbrf (4284.5 m water depth). Cores U1405B-1H through 24H were recovered to a total depth of 223.5 m DSF using non-magnetic core barrels and the FLEXIT core orientation tool. One 5-m interval was drilled ahead without coring for stratigraphic correlation. The bit cleared the seafloor at 1610 h on 28 June, ending Hole U1405B. A total of 24 piston cores were taken over a 218.5-m interval with a recovery of 219.84 m (101%). The total time spent on Hole U1405B was 29.0 hours.

The vessel was offset 20 m to the south and Hole U1405C was spudded at 1915 h on 28 June. Cores U1405C-1H through Core 25H were recovered to a depth of 232.0 m DSF

using non-magnetic core barrels and the FLEXIT core orientation tool. The 25 piston cores were taken over a 232.0-m interval with a total recovery of 227.77 m (98%). The total time spent on Hole U1405C was 33.75 hours. The seafloor was cleared at 0200 h on 30 June, ending Hole U1405C.

Overall at Site U1405, 74 APC cores recovered 693.59 m of sediment (100% recovery) and seven XCB cores recovered 24.12 m of sediments (36%). The overall recovery for Site U1405 was 95%. The total time spent on Site U1405 was 114.25 hours or 4.8 days.

The drill floor was secured and the vessel began moving in DP mode to the next site at 1.4 nmi/hr. The positioning beacon of Hole U1405C was left on site due to the risk of losing it during recovery in difficult weather conditions. The plan is to return to Site U1405 and recover the beacon after operations at Site U1406.

The vessel arrived on Site U1406 (proposed site JA-6A) at 1430h on 30 June. The APC system was deployed and recovered two water cores until the third attempt recovered a 6.25-m long mudline core. Seafloor depth was calculated to be 3826.3 mbrf. By week's end Cores U1406A-1H through 4H were recovered to a depth of 34.7 m.

SCIENCE RESULTS

The lithostratigraphy of IODP Site 1405 consists of an expanded record of Oligocene-Miocene sediments recovered in Holes U1405A, U1405B, and U1405C under a thin veneer of Pleistocene sediment. The dominant lithology is greenish grey clay with various biogenic components like diatoms, radiolarians, and calcareous nannofossils. This package, seems to correlate in age, lithology, and seismic profile to Unit II at Site U1404, and appears to make up the majority of the acoustically homogenous and largely transparent drift sediments on J Anomaly Ridge. The Oligocene-Miocene boundary section drilled at this site is perhaps the most expanded recovered to date from the oceans.

The green clay and nannofossil-biosiliceous ooze of Site U1405 yield relatively abundant microfossils providing a biozonation scheme for almost the entire succession. Nannofossils are predominantly abundant and moderately well preserved. Planktic foraminifers are generally common and well preserved throughout the sediment column. Except for the top and bottom of the hole, radiolarians occur consistently from lower Miocene to late Oligocene. As at Site U1404, abundant diatoms and well-preserved infaunal benthic foraminifers at Site U1405 suggest high productivity in the lower Miocene. According to the nannofossil biostratigraphy, this high productivity interval is similar in age to the one observed at Site U1404.

Preliminary biostratigraphic analyses suggest a continuous, lower Miocene-upper Oligocene interval with comparatively high sedimentation rates (1.4 cm/ky), and an Oligocene/Miocene transition with high sedimentation rates (~10 cm/ky).

The Oligocene/Miocene transition appears to be stratigraphically complete and contains at least one carbonate-rich layer with common to abundant Braarudosphaera. Similar layers have been described from the lower Oligocene of the North and South Atlantic Ocean. Braarudosphaera is normally restricted to shelf seas and so these range expansions may be caused by unusual paleoceanographic conditions, such as increased upwelling or climatic-driven shifts in the position of boundary currents.

Paleomagnetic work focused on routine demagnetization measurements on archive section halves from Holes U1404B, U1404C, U1405A, U1405B, and U1405C. For Hole U1405A, step-wise demagnetization behavior was also measured for approximately every-other discrete paleomagnetic sample collected. Bulk susceptibility and AMS measurements were completed on each discrete sample from Cores U1404A-1H through 9H. We chose to abandon measurements on every discrete sample for Hole U1404A because we were faced with 18 hours of trouble-shooting the SRM, which lost measurement sensitivity due to strong electromagnetic interference on the ship. The solution to the SRM problems has resulted in greater sensitivity for the SRM and the ability to extract a fairly clear reversal stratigraphy for Site 1405. Continuing work on Site U1404 shows a semi-continuous series of magnetozones that can be correlated to Chrons 12r to C19r (31.034- 41.390 Ma). Our age model agrees well with nannofossil biostratigraphy and provides a magnetostratigraphic framework for Late Eocene carbonate accumulation events and the Eocene-Oligocene transition.

The stratigraphic correlation shows that "fast-track" (special task multisensor logger [STMSL]) physical property data of Site U1404 and U1405 are inadequate for real-time depth-adjustments to monitor and direct drilling operations. The development of a reliable complete splice in the clay-rich biosiliceous sediment recovered at both sites U1404 and 1405 will require combination of shipboard physical property data, biostratigraphy and magnetostratigraphy together with initial shore-based high-resolution measurements.

During drilling of Site U1404, several observations suggested the presence of methane hydrates in the upper sediment column (~22-40 m core depth below seafloor [CSF-A]), including 1) the presence of effervescent sediment, 2) expelled section caps due to pressure, 3) bulging core liners, 4) low bulk density values, and 5) the presence of massive pyrite. High-resolution sampling was conducted to test for the existence of methane hydrates by drilling Cores U1404C-2H to 4H. Following imaging with a thermal imaging device, headspace samples and 5 cm-long whole rounds for interstitial water (IW) samples were taken on the catwalk, both at a sampling interval of one per section. After logging Cores U1404C-2H through 4H on the STMSL, rhizon sampling commenced at an interval of 50 cm through Hole U1404C.

Analysis of the Hole U1404C headspace samples yielded methane concentrations of 1.82 to 2.99 ppmv, within the range of atmospheric concentrations. No other hydrocarbon traces were detected. Results of manual titrations for alkalinity, pH, chloride, and salinity from Hole U1404C IW samples illustrated uniform depth profiles. Based on the headspace analysis of gas compounds and pore fluid data from whole round IW samples

a decision was made to archive the high-resolution rhizon samples from Hole U1404C without analyzing their chemical components. Shipboard geochemical analysis of Hole U1404C samples does not suggest the presence of methane hydrates at Site U1404.

At Site U1404, downhole profiles of pore-water components reflect a combination of: 1) organic matter degradation, 2) sorption/desorption reactions with clay minerals and chemical exchange involving other minerals undergoing diagenetic reactions, 3) up-section percolation of pore water during sediment compaction, and 4) diffusion-related gradients produced by exchange with deep sources/sinks for chemical constituents. Measured total carbon and nitrogen, and calculated total organic carbon and C/N ratios were obtained for the remainder of Site U1404. We estimated organic carbon by subtracting the inorganic carbon in wt% from the total measured carbon in wt%. The acidification protocol for direct measurement of organic carbon via flash EA was attempted and rejected. We observed unexpected leakage from the silver capsules used in the acidification process leading to sample loss and under-reporting of organic carbon and nitrogen content in the samples in the process. To account for high $CaCO_3$, we switched to the La Luna Shale standard. Carbonate contents in Hole U1404A revealed significant increases in $CaCO_3$ content in middle to upper Eocene strata as well as in the uppermost Oligocene to lower Miocene.

Meanwhile, in Hole U1405A, headspace gas, interstitial water (IW) and bulk elemental analyses (IC, TOC, TC and TN) were routinely carried out. The recognition of prominent increases in $CaCO_3$ content in lowermost Miocene to uppermost Oligocene sediments prompted sampling for additional analyses in the corresponding lithostratigraphically distinct layers in Holes U1405B and U1405C. Correlative intervals of elevated carbonate burial in the early Miocene appear to exist at both Sites U1404 and U1405.

Physical properties measurements at Site U1405 reveal an abrupt drop in magnetic susceptibility, natural gamma radiation and color reflectance at ~15 to 20 m CSF-A in all three holes. Bulk density gradually increases downhole from 1.30 to 1.60 g/cm^3 below 20 m, while water content and porosity gradually decrease from 70% to 60% and from 85% to 70%, respectively. P-wave velocity also displays a gradual increase downhole. Most of these downhole trends reflect the thick greenish, biosiliceous clay unit below 20 m.

EDUCATION AND OUTREACH

We conducted three Ship-to-Shore broadcasts this week with the Birch Aquarium at Scripps (San Diego), the National Marine Educators Conference (Alaska), and with scientist Howie Scher's children and their fellow campers at Camp Gan Israel (South Carolina). Five test calls were conducted to prepare for broadcasts in the first weeks of July. Five blog posts were added to joidesresolution.org. The most read was a post about plastic debris in the ocean seen from the JR. We held a contest on Facebook to define ELMO and win a JR t-shirt, and posted lots of popular pictures of the stormy weather. Dan Brinkhaus' second video, Expedition 342: Core on Deck was posted on YouTube (http://www.youtube.com/watch?v=IgouMVdqLDI) and already has been viewed 800 times. Dan is busy working on the third video. We are in the planning stages to do a TV

spot for the television station KBTX (College Station, TX), to do a broadcast with the website BoingBoing, and an interview with Deep-Sea News.

TECHNICAL SUPPORT AND HSE ACTIVITIES

The shipboard labs were busy processing cores. The antifreeze injection system was prepared for VSP work on the next expedition. A new amplifier was installed in the movie room. The fire drill due Friday, 29 June, was cancelled due to weather. The eye wash stations were tested Monday June 25.