IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Week 6 Report (8-14 July 2012)

OPERATIONS

Week 6 of Expedition 342, Paleogene Newfoundland Sediment Drifts, began with the recovery of Cores U1407A-9H through 15H, from 82.8 to 121.9 m drilling depth below seafloor (DSF). Core U1407A-11H was the first partial stroke and we advanced by recovery for two cores. The XCB system was deployed for Cores U1407A-16X through 35X to the final depth of 308.7 m DSF. The seafloor was cleared at 1005 h on 9 July 2012, ending Hole U1407A. Overall core recovery for Hole U1407A was 205.64 m for the 308.7 m interval cored (67% recovery). The unexpectedly low recovery is due to several empty or nearly empty cores (Cores U1407A-12H through 15H, Cores U1407A-32X though 35X). The total time spent on Hole U1407A was 50 hours.

The vessel was offset 20 m to the east and Hole U1407B was spudded at 1200 h on 9 July. Cores U1407B-1H through 11H were recovered to 95.0 m using non-magnetic core barrels and the FLEXIT core orientation tool. A 3-m interval was drilled without coring to optimize core overlap in multiple holes. Based on the recovery of an interval of chert layers in Hole U1407A, the interval from 95 to 127 m was drilled without coring using the XCB system. Cores U1407B-13X through 28X were then recovered to the final depth of 276.3 m DSF. The seafloor was cleared at 1340 h on 10 July, ending Hole U1407B. Hole U1407B recovered 234.54 m over the 241.3 m cored (97% recovery). The total time spent on Hole U1407B was 27.75 hours.

The vessel was offset 40 m to the west and Hole U1407C was spudded at 1510 h on 10 July. Cores U1407C-1H through 11H (0-93.0 m DSF) were recovered using non-magnetic core barrels; no core orientation was performed in Hole U1407C. A 3-m interval was drilled without coring to optimize core overlap in multiple holes. Once again, a 21-m interval (96-117 m) was drilled without coring through the chert layers using the XCB. Cores U1407B-13X through 29X were then recovered to the final depth

of 261.6 m DSF. The seafloor was cleared at 1805 h on 11 July. The drill string was pulled up to 2792 m drilling depth below rig floor (DRF) and the rig was secured for a dynamic positioning (DP) move to the next site at 1915 h on 11 July, ending Hole U1407C. Hole U1407C recovered 244.4 m from the 237.6 m interval cored (103%). The total time spent on Hole U1407C was 29.5 hours.

The vessel arrived at Site U1408 after a 1.46 nm transit in DP mode from Site U1407, which took 1.75 hours at 0.83 nmi/hr. The vessel stabilized over Site U1408 at 2045 hours (UTC-2.5h) on 11 July. A 4.3-m long mudline core was recovered and seafloor depth was calculated to be 3033.2 m DRF (3021.6 m water depth). Cores U1408A-1H through 20H (0-182.9 m DSF) were recovered using non-magnetic core barrels and core orientation was performed with the FLEXIT tool on the first 20 cores. Core U1408A-14H was the first partial stroke and the APC system was advanced by recovery for this and subsequent cores. The XCB system was deployed from Core U1408A-21X through 27X to a final depth of 246.5 m DSF. The seafloor was cleared at 1045 h on 13 July, ending Hole U1408A. Overall core recovery for Hole U1408A was 243.92 m for the 246.5 m interval cored (99% recovery). The total time spent on Hole U1408A was 38.00 hours.

The vessel was offset 20 m to the east. Hole U1408B was spudded at 1230 h on 13 July. Based on the mudline core recovery, the seafloor depth was calculated to be 3022.1 m. Cores U1408B-1H through 18H (0-154.5 m DSF) used non-magnetic core barrels and the FLEXIT core orientation tool was deployed only on the first four cores. It was removed when it was speculated that the weight of the FLEXIT housing might be responsible for shearing off the APC barrel at the overshot three times, slowing down coring significantly. A 3-m interval was drilled without coring to optimize core recovery in adjacent holes. The XCB system was deployed for Cores U1408B-19X through 26X to a final depth of 217.5 m DSF. The seafloor was cleared at 1700 h on 14 July, ending Hole U1408B. The recovery for Hole U1408B was 224.09 m over the 214.5 m cored (104%). The total time spent on Hole U1408B was 30.25 hours.

The vessel was offset 20 m to the south. Hole U1408C was spudded at 1905 h on 14 July. Cores U1408C-1H through 7H were retrieved using non-magnetic core barrels. The FLEXIT orientation tool was installed on Core U1408C-6H to re-capture an area of particular interest for paleomagnetics. At the end of week 6, APC coring in Hole U1408C had advanced to 59.3 m DSF.

SCIENCE RESULTS

Site U1407 (41° 25.5'N, 49° 48.8'W) is a mid-depth site (3073 m) towards the shallow end of the Expedition 342 Paleogene Newfoundland Sediment Drifts depth transect. The site is positioned to capture a record of sedimentation about 1.9 km shallower than the largely sub-carbonate compensation depth record drilled at IODP Site U1403. The location above the average late Paleogene carbonate compensation depth should be sensitive to fluctuations in carbonate burial, whether these reflect variations in dissolution related to changes in the CCD, changes in carbonate production, or variations in background non-carbonate sedimentation. Our primary scientific objectives for drilling Site U1407 were as follows: (1) to reconstruct the CCD in a primarily carbonate-dominated record for the Early and Middle Eocene, (2) to obtain records of the Eocene and Paleocene in carbonate-rich sediments that host abundant foraminifera suitable to the construction of geochemical climate records, (3) to evaluate the history of deep water on sediment chemistry, grain-size and provenance, and (4) to evaluate biological evolution during Paleogene climate transitions. Secondary objectives included dating acoustic horizons to better constrain regional sedimentation during the Paleogene and Cretaceous and allow us to anticipate the likely age of the sedimentary sequence at the remaining Expedition 342 sites.

The sedimentary sequence recovered at Site U1407 consists of Pleistocene to uppermost Lower Cretaceous pelagic sediments overlying reefal sediments of Late Albian age. The sequence has been divided into six lithostratigraphic units. Unit I is ~8 m thick, and composed of Pleistocene foraminiferal nannofossil ooze intermittently interbedded, at the decimeter scale, with foraminiferal sand and clay with nannofossils. Rock fragments of

pebble- to cobble-size and coarse silt- to sand-sized quartz and amphibole are pervasive. Unit II is a ~10 m thick sequence of Early Oligocene age composed of clay with nannofossils with disseminated manganese nodules and sulfide patches and intercalated millimeter to centimeter sulfide layers. Unit III consists of ~70 m of Middle Eocene nannofossil ooze with foraminifers; sulfide patches and layers are also present. An abrupt downhole change in color from light greenish gray into white that is associated with significant changes in physical proxies and a downhole increase in carbonate content marks the contact between Units III and IV. Unit IV consists of ~20 m of Lower Eocene nannofossil ooze with foraminifers. Unit V consists of Paleocene to Cenomanian nannofossil chalk, which is divided into two subunits (Subunits Va and Vb). The contact between lithostratigraphic Units IV and Va was not recovered because of the operations decision to drill without attempting to recover a sequence of what we interpret to be well-developed cherts. Subunit Va is composed of ~60 m of Paleocene nannofossil chalk with foraminifers and radiolarians. Subunit Vb is mainly nannofossil chalk or nannofossil chalk with foraminifers, and spans the Cenomanian to Campanian over ~85 m. Subunit Vb contains black shales of the Cenomanian-Turonian boundary age (Oceanic Anoxic Event-2 [OAE-2], ~93 Ma). Unit VI is divided into two subunits (Units VIa and VIb). Subunit VIa is ~1 m thick and comprised of fine-grained, partially silicified and dolomitized calcareous grainstone with horizontal laminations; it is of Late Albian age. Subunit VIb consists of extremely poorly recovered fossiliferous reef deposits of Albian age.

Biostratigraphy at Site U1407 is based on nannofossils and planktic and benthic foraminifers throughout the ~300-m thick Pleistocene to Albian succession of nannofossil ooze with varying amounts of clay and foraminifers. Nannofossils, planktic foraminifers and smaller benthic foraminifers are present in all but the basal Albian neritic limestone, which contains larger benthic foraminifers and macrofossils. Thin Pleistocene and lower Oligocene intervals overlie an expanded middle Eocene through upper Albian succession. Sedimentation rates are relatively high (~2 cm/ky) through the Eocene. A detailed biozonation of Upper to mid-Cretaceous sediments reveals a condensed sequence that records the Campanian/Santonian, Santonian/Coniacian, Coniacian/Turonian and

Albian/Cenomanian boundaries. Biostratigraphy of black shale recovered around 230 m core depth below seafloor (CSF-A) indicates the presence of Turonian nannofossil Zone UC6 above, and Cenomanian nannofossil zone UC5/4 below, providing strong evidence that this lithology represents OAE-2. Benthic foraminiferal assemblages support this conclusion, with the black shale dominated by agglutinated species and calcareous taxa indicating low oxygen concentrations at the seafloor. Radiolarians are abundant and well preserved in the early middle Eocene and in the Paleocene but are either absent or indeterminate in both the upper Pleistocene-late middle Eocene and lowermost Paleocene-Cretaceous intervals.

Paleomagnetic work included routine demagnetization measurements on archive section halves from Holes U1407A, 1407B, 1407C and 1408A. For Holes U1407A and U1408A, step-wise demagnetization, bulk susceptibility and AMS measurements were conducted on selected samples. For Site U1406, the identification of the Oligocene-Miocene Transition (OMT) and the Eocene-Oligocene Transition (EOT) were finalized. The shipboard magnetostratigraphic age model also indicates at least four hiatuses in Hole U1406A, none of which are longer than ~3 my. These hiatuses complicate the magnetostratigraphic correlation between the three holes at Site U1406.

A composite depth scale and splice were constructed for Site U1406. At Site U1407, real-time correlation between the three holes was possible based on magnetic susceptibility data. The Cenomanian/Turonian boundary and OAE-2 were successfully recovered in all three holes at Site U1407; we found that each lithostratigraphic expression of the OAE differed, often markedly, from the pervious hole. At Site U1408, real-time correlation is possible based on clear astronomical cycles that can be recognized in the magnetic susceptibility data. Early indications suggest that a continuous splice will be possible for large parts of the Site U1408 sedimentary column.

The geochemistry team carried out routine shipboard analyses for headspace gas samples, interstitial water profiles, and bulk sediment geochemistry for Site U1407. Methane concentrations (1.4 to 4.12 ppmv) were not above atmospheric levels. Chloride anomalies

and low pore water concentrations of the redox sensitive metals iron and manganese suggest the impact of the organic matter-rich black shale sequences (OAE-2) on diagenetic processes. We determined $CaCO_3$, TOC, and TN content on discrete samples at one per section resolution; higher density sampling commenced in Hole U1407B from sections coeval with high amplitude features captured in Hole U1407A. Carbonate content ranges from 0 to 93%. TOC values are typically 0.1–0.5%. Around ~80 m CSF-A, a sharp downhole increase in carbonate content is documented (59 to 83 wt% $CaCO_3$) and correlates with shifts in several proxies (e.g., color reflectance, magnetic susceptibility, NGR, TOC and TN values). Homogenous to micro-laminated, organic-rich black shales from Holes U1407A and U1407C are rich in TOC (~4 and 17 wt%). Organic matter is thermally immature and relatively well preserved, as shown by both the high hydrogen indices (~600-620 mg hydrocarbons per g organic carbon) and low T_{max} values (<415˚C). C/N ratios increase as organic carbon concentrations increase. Organic matter is Type II kerogen, derived from algal and microbial primary production.

A full physical properties program was run on cores from all three holes at Site U1407 and for Hole U1408A. The report for Site U1406 was finalized and results show three major trends for almost all the physical properties. (1) All physical properties show a pronounced change associated with the contact between lithostratigraphic Units I and II. (2) Throughout lithostratigraphic Unit II, there is a global increase in physical properties values downhole. (3) In lithostratigraphic Units III and IV, data show greater variability with prominent peaks that, in some cases, correlate with changes in calcium carbonate content.

EDUCATION AND OUTREACH

Week six was the busiest of the cruise so far. We completed ten videoconferences to schools, museums, and camps around the world. The highlight was speaking with the New Zealand National Aquarium – an event facilitated by Chris Hollis and his team at GNS. Expedition videos “Episode 3: Time Machine” has reached nearly 800 views on YouTube and “Episode 4” is in the final stage of production. Four blogs were posted on

the JR.org blog. The most popular was the post about Oceanic Anoxic Events (OAEs; ~700 views). Expedition 342 was featured on the blog Deep Sea News in "Drilling for Dinosaur Death: The JOIDES Resolution Finds Extinction in Deep Sea Mud". The article discusses cruise highlights such as the K-Pg, the PETM, and OAE 2, exposing the public to the importance of the JR; this article brought new visitors to our Facebook page and we have gained many new followers. Expedition posts continue on Facebook, Twitter, and tumblr. Maggie Koerth-Baker interviewed Dick Norris, Chris Junium, Jessica Whiteside, and Caitlin Scully for BoingBoing. Expedition 342 and the JR will be a feature story on their site – one of the most popular in the country. Brian Switek of Wired interviewed Jessica Whiteside for his paleontology themed blog Laelaps.

TECHNICAL SUPPORT AND HSE ACTIVITIES

The shipboard labs were busy processing cores. End of expedition shipment requirements were updated. A fire and boat drill was held on 11 July. Eye wash stations were tested Monday 9 July.