IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Week 7 Report (15-21 July 2012)

OPERATIONS

Week 7 of Expedition 342 began while recovering Core U1408C-8H at 78.3 m drilling depth below seafloor (DSF). Cores U1408C-9H through 19H (0-165.1 m DSF) were retrieved using non-magnetic core barrels. A 3-m long interval (8.8-11.8 m DSF) was drilled without recovery to optimize coverage of coring gaps in Holes U1408A and U1408B. Core orientation was performed with Cores U1408C-6H through 8H. Again, the FLEXIT tool was responsible for mechanical trouble, including one mechanical shear at the overshot and one mechanical shear of the APC shear pins. During APC operations, an intermittent electrical fault developed and coring operations were suspended for 6.5 hours while the problem was fixed. The XCB system was deployed for Cores U1408C-20X through 23X to a final depth of 187.5 m DSF. The recovery for Hole U1408C was 181.52 m over the 184.5 m cored (98.4% recovery). The total time spent on Hole U1408C was 38.25 hours. The drill string was pulled to the surface and the drill floor was secured at 0715 h on 16 July 2012 ending Hole U1408C and Site U1408. The overall percentage recovery for Site U1408 was 101%. The total time spent on Site U1408 was 106.5 hours or 4.4 days.

The vessel arrived at Site U1409 (proposed site SENR-22A) after a 26.3 nmi transit from Site U1408 that took 3.0 hours at 8.8 nmi/hr. The vessel stabilized over Site U1409 at 1010 h (UTC-2.5h) on 16 July. The pipe trip to the seafloor was interrupted at 2863.3 m drilling depth below rig floor (DRF) to install the subsea camera system. The plan was to deploy the camera near the seafloor and record the shooting of the APC, as a camera system test after repairing the damages sustained at Site U1403. After installing the camera system it was determined that the surface currents posed a serious risk to the equipment so the test was terminated and the camera system was pulled back on board. After completing the pipe trip, Cores U1409A-1H through 16H were recovered to 127.0 m DSF using non-magnetic core barrels and the FLEXIT core orientation tool. Core

U1409A-15H experienced the first partial stroke and the APC system was advanced by recovery to Core U1409A-16H. The XCB system was deployed for Cores U1409A-17X through 26X to 200.1 m DSF. The seafloor was cleared at 0550 h on 18 July, ending Hole U1409A. Overall core recovery for Hole U1409A was 183.33 m for the 200.1 m interval cored (92% recovery). The total time spent on Hole U1409A was 43.5 hours.

The vessel was offset 20 m to the east. The mudline defined the seafloor at 3512.7 m DRF (3501.0 m water depth). Cores U1409B-1H through 14H were retrieved to 122.5 m DSF using non-magnetic core barrels and the FLEXIT core orientation tool. The XCB system was deployed for Cores U1409B-15X through 19X to 170.5 m DSF. The seafloor was cleared at 0340 h on 19 July, ending Hole U1409B. The recovery for Hole U1409B was 167.09 m over the 170.5 m cored (98% recovery). The total time spent on Hole U1409B was 22.00 hours.

The vessel was offset 20 m to the south and the mudline core established the seafloor at 3512.2 m DRF (3000.5 m water depth). Cores U1409C-1H through 14H (0-124.2 m DSF) were retrieved using non-magnetic core barrels. Core orientation was not performed on Hole U1409C. XCB coring continued from Core U1409C-15X through 21X to the final depth of 160.8 m DSF. The recovery for Hole U1409C was 160.98 m over the 160.8 m cored (100% recovery). The drill string was pulled to ~3200 m DRF and the rig prepared for a transit in dynamic positioning (DP) mode to Site U1410. Poor weather conditions and high surface currents foiled the recovery of the beacon, which was declared lost at 1515 h on 20 July, ending Hole U1409C and Site U1409. The total time spent on Hole U1409C was 35.50 hours. The overall percentage recovery for Site U1409 was 96%. The total time spent on Site U1409 was 101.0 hours or 4.2 days.

The vessel arrived at Site U1410 after a 3.46 nmi DP move from Site U1409, which took 3.5 hours at 1 nmi/hr. The vessel stabilized over Site U1410 at 1845 h (UTC-2.5h) on 20 July. An 8.53-m long mudline core established seafloor depth at 3399.0 m DRF (3387.3 m water depth). Hole U1410A was spudded at 2125 h on 20 July. Cores U1410A-1H through 16H (0-151 m DSF) were recovered using non-magnetic core barrels and the

FLEXIT core orientation tool. Core U1410A-16H experienced the first partial stroke and the XCB coring system was picked up and deployed for Cores U1410A-17X through 26X. At the end of week 7, Hole U1410A had been cored to a depth of 246.7 m DSF.

SCIENCE RESULTS

We analyzed cores from two sites (U1408, U1409) targeted to capture records of sedimentation around 2 km, and 1.5 km, respectively, shallower than the largely sub-carbonate compensation depth record drilled at IODP Site U1403. Site U1408 (41° 26.3'N, 49° 47.1'W) is a mid-depth site (~3022 m; ~2575 m paleodepth at 50 Ma), at the shallow end of the Expedition 342 Paleogene Newfoundland Sediment Drifts depth transect. Site U1409 (41° 17.75'N, 49° 14.00'W) is a mid-depth site (~3500 m; ~3050 m paleodepth at 50 Ma), in the upper mid-depth end of the Expedition 342 depth transect. Our primary scientific objectives for drilling Sites U1408 and U1409 were (1) to obtain expanded sequences of Eocene calcareous ooze and chalk to reconstruct the history of both the mid-depth CCD and hyperthermal events in primarily carbonate-dominated records, (2) to obtain records of the Eocene in carbonate-rich sediments that host abundant foraminifers 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.

Sites U1408 and U1409 are examples of our offset drilling strategy to recover records of the centers of drift deposits (to obtain highly expanded records for Eocene paleocenography) and the thin edges of the same drifts where we can more easily sample sub-drift deposits. Site U1408 was located to sample an expanded sedimentary record of the middle and Lower Eocene sediments that were recovered in a more condensed section at its companion site, Site U1407. Site U1409 targets a comparatively condensed section of middle Eocene through Paleocene sediments and its nearby companion site (Site U1410) will target a much more expanded section of middle Eocene sediments.

Four lithostratigraphic units were described at both Sites U1408 and U1409. Sites U1408 and U1409 are lithostratigraphically quite similar, particularly in lithologic Units I-III. At both sites, Unit I contains inter-bedded reddish-brown clays, brown clayey silt, grey foraminiferal nannofossil ooze, and sand to pebble sized ice rafted debris in Pleistocene aged sediments. Unit I at Site U1409 also features three ~20 cm thick beds of muddy sand with foraminifers and several intervals of dark green diatomaceous nannofossil ooze. The Unit I/Unit II boundary is defined differently at Site U1408 than at Site U1409. The Oligocene sequence of manganese nodule-bearing silty clays falls in Unit I at Site U1408 and in Unit II at Site U1409. At both sites, Unit II contains yellowish brown to brown, pervasively bioturbated silty clay to nannofossil clay of Oligocene age. Unit II is underlain by the distinctive, inter-bedded, greenish-grey and white sediments of Unit III. These greenish-grey nannofossil clays within Unit III alternate with very light grey to white nannofossil ooze on roughly 50-150 cm scales, although the thickness of beds and regularity of interbedding varies both within and between sites. Unit III consists primarily of Middle Eocene aged sediments. At Site U1408, Unit IV was recovered only in Hole U1408A and consists principally of whitish and pinkish-brown, Early Eocene to Late Paleocene nannofossil chalk. At Site U1409, the Middle Eocene to Early Paleocene sediments of Unit IV are subdivided into three subunits. Subunit IVa – IVc contain i) pinkish white nannofossil oozes with radiolarians, ii) frequent cherts and highly varied lithologies including pink to dark brown or grey nannofossil ooze to chalk with interbedded chert, siliceous nannofossil limestone, and nannofossil claystone, and iii) pink to pale grey or pale brown nannofossil chalk.

Biostratigraphy at Sites U1408 and U1409 is based on nannofossils and planktic and benthic foraminifers throughout the ~250-m and ~200-m thick, respectively, Pleistocene to upper Paleocene successions. Nannofossils, planktic foraminifers and benthic foraminifers are present through most of the succession at both sites, whereas radiolarians are only present in the uppermost Pleistocene and the middle Eocene through to the upper Paleocene. Thin Pleistocene and Oligocene intervals overlie middle Eocene through Paleocene successions at both sites with significant hiatuses between the lower Pleistocene and upper Oligocene and lower Oligocene and middle Eocene. A minor

hiatus or condensed interval is also identified at the Paleocene/Eocene boundary at both sites. At Site U1409 the lower Eocene sequence is relatively complete, and the Paleocene-Eocene Thermal Maximum (PETM) is identified based on the presence of characteristic 'excursion taxa' in both the nannofossils and foraminifers. A short hiatus (~1.5 my duration) is present between nannofossil biozones NP14a and NP12 at both sites. Green clay-rich drift sediments commence abruptly immediately above this unconformity at both sites, and these earliest drift sediments contain nannofossils reworked from lower in the Eocene (Zone NP12 equivalent). This same reworking phenomenon at the onset of drift deposition was also seen at Site U1406.

Paleomagnetic work included routine demagnetization measurements on archive section halves from Holes U1408A, U1408B, U1408C, U1409A, U1409B, U1409C, and U1410A. For Holes U1408A, U1409A, and U1410A, step-wise demagnetization, bulk susceptibility and AMS measurements were conducted on selected samples. The shipboard magnetostratigraphic age models for Sites U1407 and U1408 were finalized and are similar between sites. Paleomagnetic data from both sites are of very high quality and show excellent promise for refining astronomically tuned chron boundaries and biostratigraphic datums. An exceptionally detailed record of two successive Eocene geomagnetic field transitions (C18n.1n to C18n.1r to C18n.2n) is recorded over ~6 m of sediment at Site U1408.

Following the completion of drilling operations, a composite depth scale and splice were constructed for Site U1408. The presence of clear astronomical cycles in magnetic susceptibility made it possible to complete the construction of a continuous splice down to ~233 m core composite depth below seafloor (CCSF). Clear signals in magnetic susceptibility also made it possible to correlate among holes with confidence during drilling operations at Site U1409, especially in the upper ~125 m CCSF of the sediment column. Real-time correlation was more difficult in the XCB drilled interval below ~125 m CCSF as a result of poor recovery in Hole U1409A, but initial correlation indicates that construction of a series of floating splices is possible from ~125 m to ~200 m CCSF.

The Paleocene-Eocene boundary, associated with a chert layer, was recovered in all three holes at Site U1409.

The geochemistry program conducted routine shipboard analyses for headspace gas samples, interstitial porewater geochemistry, and bulk sediment geochemistry for Site U1408. Methane concentrations (1.84 to 4.79 ppmv) were not above atmospheric levels. Concentration depth gradients of sulfate, alkalinity, ammonium, manganese and iron in Hole U1408A suggest two zones of organic matter degradation within the recovered sequence. Calcium and magnesium, and magnesium/calcium ratios reflect diffusion profiles resulting from calcium-magnesium exchange associated with alteration of volcanic basement, with inflections at ~180 m CSF-A indicating possible dissolution/reprecipitation of carbonate.

$CaCO_3$, TOC, and TN content were determined on discrete samples at 1.5 m resolution in Hole U1408A. Carbonate content in the whole sediment column at Site U1408 ranges from 0.6 to 90.5 wt% $CaCO_3$. TOC values are typically 0%–0.5% over this whole interval. Relatively high carbonate contents throughout the recovered sequence are consistent with the relatively shallow paleodepth of the site throughout the Eocene. The most prominent change in carbonate content is a step increase associated with the downhole transition from dominantly nannofossil clay to nannofossil chalk at the lithostratigraphic III/IV boundary (~50% to >80% $CaCO_3$, ~225 m CSF-A). This step increase is typical of the pattern seen in lower to middle Eocene boundary sequences recovered in Expedition 342 sites and reflects a transitionsfrom pelagic chalk sedimentation to clay deposition in the initial stages of drift development.

A full physical properties program was run on cores from Holes U1408B and U1408C, all three holes at Site U1409 and Hole U1410A including Whole-Round Multisensor Logger (WRMSL) measurements for magnetic susceptibility, bulk density, P-wave velocity, and natural gamma radiation (NGR), followed by discrete measurements on section halves for color reflectance, magnetic susceptibility, moisture and density properties, and compressional wave velocity. At Site U1408 all physical properties show

a distinct change between lithostratigraphic Units I and II. Magnetic susceptibility and NGR also show particularly distinct meter-scale variability within lithostratigraphic Unit III between about 70 and 110 m CSF-A. Physical properties data sets show prominent downhole variability at Site U1409, especially in the upper 100 m CSF-A in the case of NGR. Color reflectance shows distinctive variability both within and among lithostratigraphic units.

EDUCATION AND OUTREACH

The combined viewership for the Expedition 342 YouTube videos has exceeded 5,000 views. This puts our videos on track to be the most viewed of any expedition on the Ocean Leadership channel. Our videographer is currently producing Episode 5. Ship-to-Shore broadcasts involved campers in California, the General North Museum in Pennsylvania, a teen center in San Antonio Texas, and a group of students in South Africa. Posts continue on Facebook, Twitter, and tumblr. We achieved one of the social media goals of the expedition on the Facebook page: extended the reach (number of people who see our posts) to over 10,000 people. We have been working with PBS Newshour to do a feature on the *JOIDES Resolution* and our expedition. We will be featured on the PBS website and, depending on the footage that we are able to send, we may be featured in a segment that will also be included in the broadcasted Newshour.

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 20 July. Eye wash stations were tested Monday 16 July.