IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Week 8 Report (21-28 July 2012)

OPERATIONS

Week 8 of Expedition 342 began while completing Hole U1410A by retrieving Cores U1410A-27X and 28X to 259.8 m drilling depth below seafloor (DSF). The seafloor was cleared at 0500 h on 22 July, ending Hole U1410A. Overall core recovery for Hole U1410A was 256.88 m for the 259.8 m interval cored (99%). The total time spent on Hole U1410A was 34.25 hours.

The vessel was offset 20 m to the east. Hole U1410B (3398.7 m water depth) was spudded at 0650 h on 22 July. Cores U1410B-1H through 18H were recovered to 153.8 m DSF using non-magnetic core barrels and the FLEXIT core orientation tool. The XCB system was deployed for Cores U1410B-19X through 28X to the final depth of 245.2 m DSF. The seafloor was cleared at 1620 h on 23 July, ending Hole U1410B. The overall recovery for Hole U1410B was 244.84 m over the 245.2 m cored (100%). The total time spent on Hole U1410B was 35.25 hours.

The vessel was offset 20 m to the south and Hole U1410C (3386.9 m water depth) was spudded at 1825 h on 23 July. Cores U1410C-1H through 16H were recovered to 146.8 m DSF using non-magnetic core barrels. No core orientation was performed on cores from Hole U1410C. The XCB system was deployed for Cores U1410C-17X through 27X to the final depth of 243.8 m DSF. The overall recovery for Hole U1410C was 238.81 m out of 243.8 m cored (98.0%). The seafloor was cleared and the vessel was secured for transit at 0915 h on 25 July, ending Hole U1410C. The total time spent on Hole U1410C was 41.00 hours.

The vessel arrived at Site U1411 (proposed site SENR-11A) at 1115 h (UTC-2.5 h) on 25 July after a 19.0 nmi transit from Site U1410, which took 2.0 hours at 9.5 nmi/hr. The plan for Site U1411 called for three holes to a depth of ~250 m DSF. The first core for

Hole U1411A failed to capture the mudline and the hole was terminated after Core U1411A-1H. A second hole, Hole U1411B, was successfully cored to 254.2 m DSF. The third hole, Hole U1411C was piston cored to 9.2 m DSF, then advanced by drilling without coring by 90.8 m and then cored to a total depth of 223.9 m DSF. Because of a medical emergency, coring operations were terminated after Hole U1411C. The overall recovery for Site U1411 was 91%. The total time spent on Site U1411 was 89.75 hours or 3.7 days.

Hole U1411A was spudded at 2320 h on 25 July. Core U1411A-1H was recovered full (9.87 m) and did not recover the mudline so it was decided to abandon Hole U1411A. The seafloor was cleared at 2320 h on 25 July, ending Hole U1411A. Overall core recovery for Hole U1411A was 9.87 m for the 9.5 m interval recovered (104%). The total time spent on Hole U1411A was 12.0 hours.

The vessel was offset 20 m to the east. Hole U1411B (3298.8 m water depth) was spudded at 0035 h on 26 July. Cores U1411B-1H through 20H were recovered to 177.4 m using non-magnetic core barrels and the FLEXIT core orientation tool. The XCB system was deployed for Cores U1411B-21X through 28X to a final depth of 254.2 m DSF. The seafloor was cleared at 1310 h on 27 July, ending Hole U1411B. The recovery for Hole U1411B was 233.94 m over the 254.2 m cored (92%). The total time spent on Hole U1411B was 38.0 hours.

The vessel was offset 20 m to the south. Hole U1411C (3300.5 m water depth) was spudded at 1505 h on 27 July. Cores U1411C-1H through 2H were recovered to 9.2 m DSF. After Core U1411C-2H, the hole was advanced by drilling without coring to 100 m DSF in order to save operational time for deeper objectives. After the drilling advance, APC coring continued with Cores U1411C-4H through 9H (100-152.2 m DSF). All APC cores were oriented with the FLEXIT core orientation tool and were recovered using non-magnetic core barrels. The XCB system was deployed for Cores U1411C-10X through 17X to a final depth of 223.9 m DSF. Following Core U1411C-17X, a medical emergency led to the decision to terminate operations and transit to St. John's,

Newfoundland. The seafloor was cleared and the vessel was secured for transit at 0500 h on 29 July, ending Hole U1411C. The recovery for Hole U1411C was 118.62 m over the 133.1 m cored (89%). The total time spent on Hole U1411C was 39.75 hours.

SCIENCE RESULTS

Site U1411 (proposed site SENR-11A; 41° 37.1'N, 49° W) is a mid-depth site (~3300 m; ~2850 m paleodepth at 50 Ma, Tucholke and Vogt, 1979), in the upper end of the Expedition 342 Paleogene Newfoundland Sediment Drifts depth transect. The site is positioned to capture a record of sedimentation around 1.65 km shallower than the largely sub-carbonate compensation depth record drilled at IODP Site U1403. Our primary scientific objectives for drilling Site U1411 were (1) to obtain an expanded record of the upper half of a Miocene-lower Eocene sediment drift to compare directly to the timing and nature of drift development at the Sites U1407-U1408 drift and the Sites U1409-U1410 drift; (2) capture fine-scale variations in carbonate preservation and lysocline shifts in Miocene-Eocene carbonate-rich sediments that are about 550 m shallower than the Site U1406 Oligocene-Miocene section; and (3) to evaluate the history of deep water and the carbonate compensation depth on sediment chemistry, grain-size and provenance. Secondary objectives include the possible recovery of the Oligocene-Miocene and Eocene-Oligocene boundaries for comparison with the record of these events elsewhere, particularly Sites U1404-U1406 along the Expedition 342 depth transect.

At Site U1411, we recovered a 254.5 m thick sedimentary succession of deep-sea, pelagic sediments of Pleistocene to Late Eocene age highlighted by an expanded record of the Eocene-Oligocene Transition. The sedimentary sequence at Site U1411 comprises three lithostratigraphic units. Unit I is a 13.45 m thick succession of classically Pleistocene sediments of alternating gray and reddish brown clayey foraminiferal ooze, gray silty sand with foraminifers, and brown to grayish brown silty clay with foraminifers. Dropstones and sand-sized lithic grains are prominent in Unit I. Unit II is a 198.23 m thick succession of silty clay, clay with nannofossils and silty nannofossil clay of Early Miocene to Late Eocene age. Nannofossil ooze is also present in Unit II, but only in the

interval immediately after the Eocene-Oligocene Boundary. Small blebs of quartz silt on core surfaces, interpreted as ice-rafted debris are very common in the Miocene and Oligocene sediments of Unit II. Unit III is 41.92 m thick and composed of greenish gray and dark greenish gray nannofossil clay with foraminifers, clayey nannofossil chalk with foraminifers, and clayey foraminiferal chalk. Laminated intervals, some of which highly concentrated in foraminifers, are common in Unit III, which has evidence for significant reworking and winnowing by currents associated with drift formation.

Biostratigraphy at Site U1411 is based on nannofossils and planktic and benthic foraminifers throughout the ~255-m thick Pleistocene to upper Eocene succession of nannofossil ooze with varying amounts of clay and foraminifers. Nannofossils, planktic foraminifers and benthic foraminifers are present in all sequences. A short barren interval occurs between the Pleistocene and lower Miocene-Eocene sequence. Radiolarians are only present in the uppermost Pleistocene. A relatively thin Pleistocene sequence overlies a lower Miocene to mid-Oligocene succession with relatively poor carbonate microfossil preservation, followed by an expanded lower Oligocene through upper Eocene succession. The Eocene/Oligocene boundary transition has sedimentation rates of up to ~3 cm/ky. While preservation of calcareous microfossils in middle to upper Oligocene is poor as seen in the previous sites on Southeast Newfoundland Ridge, lower Oligocene contains exceptionally well-preserved fossils.

Paleomagnetic work included routine demagnetization measurements on archive section halves from Holes U1410A, U1410B, U1410C, U1411B, and U1411C. For Holes U1410A and U1411B, step-wise demagnetization, bulk susceptibility and AMS measurements were conducted on selected samples. Two series of magnetostratigraphies were identified for Site 1410. The first interval spans the Pleistocene, whereas the second interval spans all but the uppermost of the Middle Eocene. The Site U1410 magnetochronology suggests that average linear sedimentation rates (LSRs) were ~1.5-2.3 cm/ky during the Pleistocene, with higher sedimentation rates during Chron C2 than during Chron C1. Average LSRs varied from 1.30 cm/ky at the beginning of the Middle Eocene to 1.98 cm/ky at the end of it. Middle Eocene LSRs peaked at 2.63 cm/ky during

Chron C20n, which is one chron younger than the interval of peak LSRs at Site U1409. Finally, the geomagnetic field transitions from C18n.1n to C18n.1r to C18n.2n are recorded in exceptional detail in Hole U1410B, and show remarkably similar behavior as the same transitions recorded at Site U1408. For Site U1411, an Oligocene to Early Eocene magnetostratigraphy was identified. This magnetostratigraphy indicates a nearly complete and expanded Oligocene record (1.53 cm/ky average LSR, with peak LSRs of 3.22 cm/ky); a hiatus of <1 m.y. in the lower Oligocene; a highly expanded Eocene-Oligocene Transition (2.63 cm/ky average LSR, with peak LSRs of 5.02 cm/ky); and at least three cryptochrons within C13r, one of which occurs in the same stratigraphic interval as the first downhole appearance of the Eocene marker foraminifer *Hantkenina alabamensis*.

Following the completion of drilling operations, a composite depth scale and splice were constructed for Site U1410. Due to the presence of clear astronomical cycles in magnetic susceptibility, the splice is continuous down to ~228 m core composite depth below seafloor (CCSF). Hole U1411A failed to recover a mudline and only extended to 9.2 m DSF. Hole U1411B cored to a total depth of 254.2 m DSF. Due to time constraints, Hole U1411C was advanced without recovery from 9.2 to 100 m DSF. Real-time correlation was possible between Holes U1411B and U1411C from ~100 m CCSF to the base of Hole U1411C at ~220 m CCSF. Drilling successfully recovered a spliced record, including the Eocene-Oligocene transition, from ~103-169 m CCSF. XCB coring achieved poor recovery of Cores U1411B-21X and 22X as well as Cores U1411C-13X and 14X, so there is a large gap in the spliced record from ~180 to 201 m CCSF.

The geochemistry program this week completed routine shipboard analyses for headspace gas samples, interstitial pore water geochemistry, and bulk sediment geochemistry for Site U1410 (reported here) and Site U1411 (to be reported in Site U1411 summary). At Site U1410, methane concentrations (2.11 to 4.12 ppmv) were not above atmospheric levels. As with our other Southeast Newfoundland Ridge drill sites (Sites U1407-U1409), interstitial pore water profiles display evidence of compartmentalization with pronounced abrupt downhole shifts in magnesium, manganese and potassium at ~220-230 m CSF-A,

suggesting that the unrecovered sequence of cherts functions as an aquiclude. Overall, interstitial pore water profiles of potassium, calcium, and magnesium are consistent with those resulting from exchange with, and alteration of basaltic basement at depth. Downhole patterns of manganese, iron and sulfate indicate modest organic matter degradation. Alkalinity, ammonium and manganese concentrations are low and sulfate concentrations are high. A broad downhole peak in boron concentrations at ~30 m CSF-A presumably indicates increased supply from the terrigenous sediment component in lithostratigraphic Unit II.

Carbonate content in the sediment column at Site U1410 ranges from ~0.7% to 93%. The most prominent changes are 1) the downhole transition from Pleistocene nannofossil ooze of lithostratigraphic Unit I (~40 wt% average) to Late Miocene to Oligocene clay of lithostratigraphic Unit II (~10 wt%); 2) the downhole transition (70 m CSF-A) from lithostratigraphic Unit II to Unit III, a Middle Eocene sequence made up of alternations of clay and white nannofossil ooze (carbonate content ~30 and 80 wt%, respectively); and 3) a downhole step-decrease in carbonate content associated with the Middle to Lower Eocene boundary (~92-46 wt%, ~210 m CSF-A). As observed in the previous Southeast Newfoundland Ridge sites, this step correlates with excursions in several proxies (e.g., color reflectance, magnetic susceptibility, NGR, TOC and TN values) and marks a transition in time from pelagic chalk sedimentation to clay deposition in the initial stages of drift development.

TOC values are typically 0.01%–0.57% throughout the sediment column. Organic matter is thermally immature and relatively well preserved with low T_{max} values (380°-420°C). Organic matter throughout the sediment column is a mixture of Type II (algal and microbial) and Type III (land plant/detrital) kerogen.

In the middle of the week, we began to measure pore fluid constituents from Hole U1411A samples. Measurements on interstitial water, solid sediments, and organic matter characterization are underway.

During week eight, a full physical properties program was run on cores from all three holes at Site U1410 and for Hole U1411A, 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.

EDUCATION AND OUTREACH

The combined viewership for the Expedition 342 YouTube videos has exceeded 8,000 views. Expedition 342 Episode 1 is now listed in the top 10 most viewed videos on the Ocean Leadership YouTube channel. Episode 5 was uploaded this week and is already very popular. The shipboard videographer is busy producing Episode 6. Ship-to-Shore broadcasts involved campers in Florida and a teen center in San Antonio, Texas. The highlight of the week was participating in the annual Bryce Canyon National Park Geology Festival and the broadcast was a special ranger program. Posts continue on Facebook, Twitter, and tumblr.

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 28 July. Eye wash stations were tested Monday 23 July.