IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Site U1408 Summary

Background and Objectives

Site U1408 (proposed site SENR-21B; 41° 26.3'N, 49° 47.1'W) is a mid-depth site (~3022 m water depth; ~2575 m paleodepth at 50 Ma, Tucholke and Vogt, 1979), in the shallow end of the Expedition 342 Paleogene Newfoundland Sediment Drifts depth transect. The site is positioned to capture a record of sedimentation around 2 km shallower than the largely sub-carbonate compensation depth record drilled at IODP Site U1403. The location, well above the average late Paleogene carbonate compensation depth, should be sensitive to both increases and decreases 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. The site is also intended to sample the core of a small sediment drift for comparison with the age structure and depositional processes of other drift deposits on Southeast Newfoundland Ridge and J Anomaly Ridge.

Principal Results

The vessel arrived at Site U1408 (SENR-21B) after a 1.46 nmi transit from Site U1407 in dynamic positioning mode, which took 1.75 hours at 0.83 nmi/hr. The vessel stabilized over Site U1408 at 2045 h (UTC-2.5h) on 11 July 2012. Cores U1408A-1H through 20H were retrieved using non-magnetic core barrels and the FLEXIT core orientation tool. Core U1408A-14H experienced the first partial stroke and the APC system was advanced by recovery to the APC total depth of 182.9 m drilling depth below seafloor (DSF). The XCB system was deployed for Cores U1408A-21X through 27X to the final depth of 246.5 m DSF. The seafloor was cleared at 1045 h on 13 July 13, 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 and Cores U1408B-1H through 18H were retrieved using non-magnetic core barrels and the FLEXIT core orientation tool. A 3-

m long interval (25.7-28.7 m DSF) was drilled without recovery to optimize coverage of coring gaps in Hole U1408A. Coring was slowed down when the FLEXIT housing sheared at the overshot connection above the core barrel three times during APC coring in Hole U1408B. Total advance including the drilled interval with the APC system was 154.5 m. 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 (105% recovery). The total time spent on Hole U1408B was 30.25 hours.

The vessel was offset 20 m to the south and Hole U1408C was spudded at 1905 h on 14 July. Cores U1408C-1H 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 Hole U1408A. Core orientation was performed with Cores U1408C-6H through 8H. Again, the FLEXIT tool was thought 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 h 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% 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 ending Hole U1408C and Site U1408. The overall recovery for Site U1408 was 106%. The total time spent on Site U1408 was 106.5 hours or 4.4 days.

The ~250-m thick sedimentary succession recovered in Holes U1408A, U1408B, and U1408C consists of pelagic deep-sea sediments of Pleistocene to late Paleocene age, however, all stratigraphic epoch boundaries (Paleocene-Eocene, Eocene-Oligocene, Oligocene-Miocene) are represented by hiatuses. The succession is subdivided into four lithostratigraphic units. Unit I is ~13 m thick and includes sediments of Pleistocene to Oligocene age. These are composed of brown silty clay at the top, followed by decimeter-scale alternations of brownish foraminiferal nannofossil ooze and reddish-brown clay. These likely represent Pleistocene glacial-interglacial cycles. Manganese nodules and dropstones are common. The 10-m-thick Unit II consists of

well-homogenized, silty clay with nannofossils and nannofossil clay with silt of Oligocene age. Sand-sized lithoclasts are found in the >63 μm size fraction from Section U1408-4H-3 (NP23 nannofossil biozone, Oligocene) upwards. Unit III is 202 m thick and displays a predominantly greenish gray color, but also cyclical color changes between greenish gray to dark green and very light-gray intervals on a decimeter-scale. Burrowing is mostly of moderate intensity, in particular Zoophycos, Planolites and Chondrites burrows are common. Unit IV was recovered only in Hole U1408A and consists principally of whitish and pinkish-brown nannofossil chalk. This unit spans parts of the early Eocene and the late Paleocene. Biostratigraphy constrains the Paleocene/Eocene boundary close to the base of Section U1408A-26X-2; however, the Paleocene-Eocene Thermal Maximum was not recovered due to an unconformity.

Nannofossils, planktic foraminifers and benthic foraminifers are present through most of the Pleistocene to upper Paleocene succession recovered at Site U1408. Radiolarians are only present in a short interval of the middle Eocene and upper Paleocene. Thin Pleistocene, upper Miocene and lower Oligocene intervals overlie a middle Eocene through upper Paleocene succession with significant hiatuses between the Oligocene and middle Eocene (~7 my) and middle and lower Eocene (~3 my), and a minor hiatus or condensed interval around the Paleocene/Eocene boundary. Sedimentation rates are high (~1.49-3.14 cm/ky) through the middle Eocene, low through the lower Eocene (around 0.08 cm/ky), and relatively high through the upper Paleocene (~1.27 cm/ky).

Shipboard results reveal a series of normal and reversed magnetozones between Cores U1408A-4H and 25X (~29-220 m core depth below seafloor [CSF-A]), between Cores U1408B-5H and 18H (~30-154 m CSF-A), and between Cores U1408C-5H and 19H (~35-165 m CSF-A). These magnetostratigraphies can be correlated between all three holes and consist of lower Chron C17n.3n (~ 38.3 Ma) through upper Chron C20r (~43.4 Ma). The geomagnetic field transitions from C18n.1n to C18n.1r to C18n.2n are recorded in exceptional detail in all three holes at Site U1408. Chron C20r is continuously recognized down to the bottom of the APC-cored interval and continues into the XCB portion where we recognize the C20r/C21n chron boundary (45.724 Ma). The magnetochronology suggests that sedimentation rates varied

between ~1.5 and 3.14 cm/ky across the Middle Eocene. Sedimentation rates were higher before the Middle Eocene Climatic Optimum (MECO, ~41.5 Ma) than after it.

Physical properties at Site U1408 largely reflect compaction and calcium carbonate content. Bulk density globally increases downhole from 1.40 to 1.95 g/cm^3 but an abrupt step down to ~ 1.4 g/cm^3 occurs at the transition between lithostratigraphic Units I and II. Grain density averages 2.77 g/cm^3 in Hole U1408A. Overall in Hole U1408A, water content and porosity show a decreasing trend downhole (from 50% to 25% and from 75% to 50%, respectively). P-wave velocity increases progressively downhole from 1500 to 1800 m/s. Color reflectance parameters a* and b* show higher values in lithostratigraphic Units I, II and IV and display cyclicity in lithostratigraphic Unit III (a* averages 0.5 and b* averages -0.35). Magnetic susceptibility drops from ~60 to 10 IU at 12 m CSF-A and also cycles regularly around an average value of ~14 IU to the bottom of the sediment column. NGR and L* show a relatively low variability and average 25 cps and 55 respectively. Throughout lithostratigraphic Unit III, variations in magnetic susceptibility, NGR and L* correlate with calcium carbonate content (with peaks at ~95, 155 and 230 m CSF-A).

A clear signal in magnetic susceptibility resulted in an accurate splice of the three holes at Site U1408. The expression of orbital (most likely precession) cycles between 35 and 220 m core composite depth below seafloor (CCSF) was a particular aid to the correlation. The overall trends and patterns between holes are very similar amongst the three holes. The splice for the upper 150 m CCSF of the section is quite robust and could be used for high-resolution sampling. However low variability in magnetic susceptibility between 70 and 80 m CCSF and between 150 and 226 m CCSF creates intervals with a tentative splice. Our correlation results in a growth rate of 13%.

The downhole patterns of alkalinity, manganese and iron suggest two zones of organic matter degradation within the recovered sequence. Very high concentrations of manganese in the upper 30 m CSF-A coupled with iron concentrations of 0 μm suggest ongoing oxic to suboxic diagenesis driven by microbial reduction of manganese oxides. Below 30 m CSF-A the reduction of iron oxides is evident from the rapid increase in iron concentrations. The broad peak in iron between 40 and 90 m

CSF-A suggests a locus of organic matter consumption within this depth. Increasing alkalinity concentrations beginning at 50 m CSF-A corroborate this interpretation. Relatively high carbonate contents throughout the recovered sequence in Hole U1408A are consistent with the relatively shallow paleodepth of the site throughout the Eocene. Carbonate concentrations are roughly 40 wt% in lithostratigraphic Unit I and fall to 0-10 wt% in lithostratigraphic Unit II, which is consistent with low carbonate levels observed in other Oligocene sequences recovered during Expedition 342. In the expanded middle Eocene sequence represented by Unit III, carbonate content ranges from 40 to 50 wt%, with a few peaks up to 80 to 90 wt%. Carbonate content increases to 90 wt% in Unit IV, which corresponds to lower Eocene sediments. The downhole increase in carbonate content at the lithostratigraphic Unit III/IV boundary (225 m CSF-A) is typical of the early to late Eocene boundary in Expedition 342 sediment cores. It is possible that the change in carbonate is linked to a change in production, preservation, or dilution by other sedimentary components.