IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Site U1405 Summary

Background and Objectives

Site U1405 is a mid-depth site on the Expedition 342 Newfoundland Sediment Drifts depth transect. Principal goals include (i) to test the hypothesis that the seismically homogenous package prominent on J Anomaly Ridge is a plastered drift deposit of Paleogene age, (ii) to obtain a sedimentary section suited to paleoceanographic study at suborbital timescales featuring very high rates of deposition compared to those typically found in deep sea pelagic sites (1-2 cm/ky) and (iii) to capture excursions of the Cenozoic calcite compensation depth (CCD).

Principal Results

The vessel arrived at Site U1405 (proposed site JA-14A; 4280 m water depth) at 0745 h (UTC-2.5h) on 25 June 2012, after a 7.5 nmi transit from Site U1404. The plan for Site U1405 called for three holes to a depth of ~250 m drilling depth below seafloor (DSF).

Cores U1405A-1H through 26H were recovered to 241.9 m DSF. APCT-3 formation temperature measurements were taken on Cores U1405A-4H, 7H and 10H with good results. Core U1405A-26H was the first partial stroke and the core had to be pumped out of the core barrel. The XCB system was deployed for Cores U1405A-27X through 33X to a total 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 vessel was offset 20 m to the east and Cores U1405B-1H through 24H were recovered to a total depth of 218.5 m DSF. An interval of 5 m was drilled without coring in an attempt to cover coring gaps in Hole U1405A. Coring the 218.5 m interval yielded 219.60 m of core (101% recovery). The vessel was offset 20 m to the south and Cores U1405C-1H through 25H were recovered to a total depth of

232.0 m DSF. The cored interval of 232.0 m yielded 227.77 m of core (98% recovery). The seafloor was cleared at 0200 h on 30 June, ending Hole U1405C. After clearing the seafloor the drill string was raised to ~3500 m drilling depth below rig floor (DRF) and the vessel began moving in dynamic positioning mode to the next site at a speed of 1.5 nmi/hr. The positioning beacon was left on site for a later recovery to minimize the risk of losing it during recovery in difficult weather conditions. The total time spent on Site U1405 was 4.8 days.

The lithostratigraphy of Site U1405 is composed of ~20 m of Pliocene-Pleistocene nannofossil ooze and clay (Unit I) overlying an expanded sequence (~250 m thick) of a Upper Oligocene through Lower Miocene distinctive greenish-gray colored clay and ooze (Unit II). Unit II contains varying abundances of radiolarians, diatoms, and nannofossils and is subdivided largely according to changes in carbonate content (range ~0 to 30%). Pale carbonate-rich intervals are present around the Oligocene-Miocene transition. Some of these intervals contain common to abundant Braarudosphaera nannofossil occurrences and even thin (1-2 mm), discrete Braarudosphaera ooze layers that have been disrupted by bioturbation. Signal processing of light reflectance data reveals significant peaks in spectral power concentrated at wavelengths of ~16 and ~4 m, indicating a possible orbital control over sediment composition that may be particularly useful for detecting hiatuses and changes in sedimentation rate.

Biostratigraphic analysis of Site U1405 shows that the site records a middle Miocene (~14 Ma) to late Oligocene (~30 Ma) succession with a thin (0-6.2 m), Plio-Pleistocene cover. Between 6.2 and 26.2 m core depth below seafloor (CSF-A) siliceous and calcareous microfossils are absent. Below 26.2 m CSF-A, nannofossils, radiolarians and planktic foraminifers provide a well-defined biostratigraphy that is in good agreement with paleomagnetic chron boundaries. Nannofossils are predominantly abundant and moderately well preserved. Planktic foraminifers are generally common and well preserved throughout the hole. Except for the top and bottom of the hole, radiolarians occur consistently from the Early Miocene to Late Oligocene. As seen in Site U1404, abundant

diatoms suggest high productivity in the lower Miocene, supported by the occurrence of well-preserved infaunal benthic foraminifer assemblages that imply high organic matter flux to the seafloor. The lower Miocene interval has comparatively high sedimentation rates (3.3 cm/ky), while the Oligocene/Miocene transition has still higher sedimentation rates (~10 cm/ky). Paleomagnetic data indicate a potential hiatus between 19 and 21.5 Ma.

Paleomagnetic results from Site U1405 reveal a continuous series of normal and reverse magnetozones in all three holes, between ~39 and ~240 m CSF-A. Magnetozones can be straightforwardly correlated between all three holes, especially below ~90 m CSF-A. Although the pattern and stratigraphic thickness of magnetozones in all three holes is similar, there are significant offsets between the CSF-A depths of these magnetozone boundaries in Hole U1405A and those in Holes U1405B and U1505C. We primarily used nannofossil and foraminifer biostratigraphy to correlate Hole U1405A magnetostratigraphy to chron boundaries C5Br/C5Cn.1n (15.974 Ma) through C5Cn.2r/C5Cn.3n (16.543 Ma), and C6AAr.3r/C6Bn.1n (21.767 Ma) to C6Cn.3n/C6Cr (23.295 Ma) on the geomagnetic polarity timescale (GPTS). This correlation provides a shipboard chronostratigraphic framework for interpreting the latest Late Oligocene-Middle Miocene at this site. Hole U1405A magnetostratigraphy indicates at least two substantial (1-3 Ma) unconformities during rapid (~3.3-5.7 cm/kyr) deposition of the Middle-Late Miocene green clay drift deposits, whereas in Holes U1405B and U1405C, only one of these hiatuses is recognized.

Real time stratigraphic correlation at Site U1405 was difficult because magnetic susceptibility data were below the detection limit for most of the sediment column in Holes U1405A, U1405B, and U1405C. A prominent color change from tan to greenish-grey in the top three cores provided a clear correlation between the three holes. This was used to make initial adjustments to drilling operations in order to offset coring gaps. The majority of the recovered strata at Site U1405 were Miocene to Oligocene in age; these sediments were very homogenous and showed few distinctive features down to ~200 m CSF-A. A clear color change and associated GRA bulk density peak present in all three holes provided a strong tie

just below the Oligocene/Miocene boundary. This tie suggests that we successfully recovered a complete O/M transition between the three holes. Whole-core physical properties data series between these two ties are not straightforward to interpret. There may be large lateral variations in the drift that cause differences in the recovered strata between each hole. As a result, most of our tie points are tentative, and the splice for Site U1405 will require postcruise revision.

Headspace gas results from routine safety monitoring revealed methane in low concentrations (1.59–3.49 ppmv). Higher molecular weight hydrocarbons were not detected in measurable amounts. Calculated TOC values are typically low (~0.2 to 0.5) with highest values (>2%) in the middle of lithostratigraphic Unit IIa (at 50–150 m CSF-A). Pore water profiles from Hole U1405A suggest organic matter degradation via manganese oxide and iron oxide metabolic pathways. The downhole interstitial water concentration profile for manganese, iron, sulfate and ammonium suggest that organic matter consumption has not driven pore fluid geochemistry to sulfate reduction. Pore fluid pH and alkalinity profiles show regular trends downcore (decreasing and increasing, respectively) and reflect changes in dissolved inorganic carbon in response to organic matter consumption. Pore fluid concentrations of calcium and strontium, and elemental ratios of Sr/Ca and Mg/Ca, suggest that two processes are at work: 1) carbonate recrystallization and 2) exchange reactions with the basaltic basement (a source of Ca and sink for Mg) and diffusion through the sedimentary sequence. Additionally, potassium concentrations have been modified through authigenic alteration of clay minerals.

Carbonate content is generally between 0 to 10 wt%, but increases to 10 to 20 wt% in the lower portion of Unit IIa. Several distinct intervals of high carbonate (up to 46 wt%) and low carbonate (<15 wt%) are observed. Based on the shipboard biostratigraphic and paleomagnetic derived age model, high carbonate intervals in Unit IIa are likely to correspond with lowermost Miocene and upper Oligocene carbonate peaks observed at Site U1404. Intervals of

carbonate in the uppermost Oligocene are driven by calcareous nannofossil abundance, particularly the taxon *Braarudosphaera*.

Almost all of the physical properties measured at Site U1405 show two major trends, related to the lithostratigraphy. Magnetic susceptibility, color reflectance parameters a* and b* and bulk density show higher values in lithostratigraphic Unit I than lithostratigraphic Unit II, whereas porosity and water content show the opposite trend. P-wave velocity gradually increases downhole from 1500 to 1650 m/s, a typical compaction trend similar to that seen in bulk density and water content in lithostratigraphic Unit II. Color reflectance L* and NGR measurements show different trends in all three holes, which suggests lateral heterogeneity in the sediment section in agreement with paleomagnetic results. Subtle changes in color reflectance, L* likely reflect cyclic changes in calcium carbonate.