IODP Expedition 342: Paleogene Newfoundland Sediment Drifts
Site U1403 Summary

Background and Objectives

Site U1403 (proposed site JA-01) is the first and the deepest water site to be drilled on the J Anomaly Ridge, pinning the deep end of the Paleogene Newfoundland sediment drifts depth transect. The site is positioned to capture deep excursions of the calcite compensation depth (CCD) during the Paleogene and to help improve stratigraphic control on the sediments to be drilled on J Anomaly Ridge. A secondary goal at Site U1403 was to identify the age and lithology of a reflector-rich sediment package that lies beneath the acoustically homogenous unit that is a primary drilling target for Expedition 342.

Principal Results

After a 946 nmi transit from Site U1402 the vessel stabilized over Site U1403 at 1708 h (UTC-2.5h) on 11 June 2012. The original plan called for three holes to a depth of ~250 m DSF (driller's depth below seafloor), but the science decision was ultimately to complete operations with two holes: Hole U1403A to 253.3 m DSF, and Hole U1403B to 265.1 m DSF. Hole U1403A was spudded at 1020 h on 12 June. The water depth based on the 5.85-m long mudline core was 4944.3 m. The APC system recovered Cores U1403A-1H through 17H, where a hard layer was encountered at ~148 m DSF. The XCB system was deployed for Cores U1403A-18X through 29X to a final depth of 253.3 m DSF. The seafloor was cleared at 1240 h on 14 June, ending Hole U1403A. Overall core recovery for Hole U1403A was 231.82 m for the 253.3 m interval cored (91% recovery).

The vessel was offset 20 m to the east and Hole U1403B was spudded at 1730 h on 14 June. The intent was to recover ~8 m in the mudline core. The 3.9 m core recovery was a surprise, yielding a water depth of 4948.7 m, 4.4 m deeper than recorded in Hole U1403A. This, and correlation of features across the two holes, led to the suspicion that the water depth estimate for Hole U1403A was incorrect for unknown reasons. The APC coring system was used for Cores U1403B-1H through16H. The XCB system was deployed for Cores U1403B-17X through 18X, until we broke through the chert layers at 150.4 m DSF. The APC coring system was again deployed

for Cores U1403B-19H through 22H to a depth of 175.9 m DSF. After a partial stroke core with a 2.97 m recovery, the XCB system was again deployed for Cores U1403B-23X through 32X, to a final depth of 265.1 m DSF. Overall, core recovery for Hole U1403B was 229.81 m for the 265.1 m cored interval (87% recovery).

Site U1403 yielded diverse types of deep-sea pelagic sediments within five lithologic units of Pleistocene to Late Cretaceous (Campanian) age. Core recovery and condition were excellent overall and included records of the K-Pg Boundary Extinction Event, the Late Eocene Chesapeake Bay impact and the Eocene hyperthermals ETM2 and PETM. The majority of the Paleogene is carbonate poor but relatively rich in siliceous microfossils. This record is consistent with paleo-depths below the local calcite compensation depth (CCD), and anchors the deepest water site of the Expedition 342 depth transect. Initial results reveal episodic deepening of the calcite compensation depth (CCD), which may be evidence of carbonate compensation "overshoots" that enhance carbonate deposition in the deep sea, a predicted response to transient global warming and ocean acidification events.

The downhole lithostratigraphy at Site U1403 includes foraminifer sandy clay, unfossiliferous clay, red, brown, and black chert, clay with radiolarians, clay with nannofossils and radiolarians, nannofossil ooze and chalk. Uppermost sediments include foraminifer sand with manganese nodules that overly a succession of unfossiliferous clay, and clay with nannofossils and radiolarians. Chert horizons are present below 150 m between intervals of radiolarian clay and nannofossil ooze and chalk. The chert horizons are typically poorly recovered. A thin, graded, green spherule horizon is present at the K-Pg boundary and interpreted as debris from the Chicxulub impact event. Underlying sediments largely consist of color banded nannofossil chalk to a depth of ~262 m.

Site U1403 recovered a sequence of Holocene-Pleistocene to Campanian sediments. Quaternary calcareous nannofossils and planktic foraminifers are present in the uppermost 2 m of the section, but from 2 to 70 m the sediments contain no age-diagnostic fossils. Calcareous nannofossils and radiolarians indicate a middle Eocene (44.5 Ma) and lower Eocene to K-Pg boundary sequence from ~70 to 220 m. Radiolarian assemblages are diverse and well preserved in the middle and lower

Eocene and provide the only age control between 70 and 119 m CSF-A. Preliminary biostratigraphic analysis suggests that minor hiatuses may exist in the lower Eocene and middle-upper Paleocene. Fossiliferous sequences of both the PETM and ETM-2 hyperthermal events were recovered and include "excursion" calcareous nannofossil assemblages. The K-Pg boundary section appears to be biostratigraphically complete. A high diversity uppermost Maastrichtian calcareous nannofossil assemblage occurs below the K-Pg impact ejecta bed and very low diversity, post–mass-extinction assemblages occur above this bed. Earliest Danian assemblages are dominated by calcareous dinoflagellates and a handful of Cretaceous calcareous nannofossil survivor species, and are followed up-section by a record of nannoplankton recovery and diversification. Hole U1403B bottomed at ~262 m in upper Campanian sediments consisting largely of nannofossil chalk. Planktic foraminifers are absent or very poorly preserved through most of the succession, except for an interval of well-preserved assemblages in the lowermost Danian and uppermost Maastrichtian. Benthic foraminiferal assemblages characterized by calcareous taxa are present throughout the Paleocene to Cretaceous.

Paleomagnetic results from Site U1403 revealed a continuous series of normal and reverse magnetozones between Sections U1403A-6H-1 and 16H-1 (~46-140 m CFS-A) and between Sections U1403B-6H-5 and 16H-5 (~41-137 m CFS-A). This magnetic stratigraphy correlates well to Chrons C16n.1r through C22n on the geomagnetic polarity timescale, and indicates that we have collected a continuous Early to Late Eocene section (35.892-49.344 Ma). Site U1403 magnetostratigraphy also indicates that the distinctive gray-blue interval at U1403A-6H-2, 80-120 cm and U1403B-6H-5, 50-90 cm was deposited during C16n.1n (35.706-35.892 Ma). Thus, this stratigraphic interval, which is characterized by the occurrence of euhedral feldspars and a large spike in natural gamma ray radiation, marks the Chesapeake Bay Impact event.

A partially spliced composite depth record was produced for Holes U1403A and U1403B. The mudlines could not be reliably aligned owing to an inconsistency in the apparent seafloor depths between the two holes. A composite spliced record was achieved between Holes U1403A and U1403B from ~20 and 150 m CCSF (core composite depth below seafloor). Below 150 m CCSF, where chert layers were

encountered in both holes, floating composite sections for the ETM2, PETM, and the K-Pg boundary and upper Maastrichtian were constructed.

Age-depth relationships are based largely upon biostratigraphic datums for radiolarians and calcareous nannofossils in Hole U1403A and a combination of paleomagnetic data from Holes U1403A and U1403B. The upper ~46 m of the sediment column at Site U1403 is undated other than an ~2 m-thick layer of Holocene-Pleistocene sediment. The magnetostratigraphic identification of C16n.1n (35.706-35.892 Ma) in Core U1403-6H (and discovery of the same interval in Hole U1403B) represents the first of a series of dated Paleogene horizons at Site U1403. Our correlation indicates that average clay accumulation rates from ~40-50 Ma were ~1 cm/ky, and diminished to ~0.2 cm/ky from ~35-40 Ma. Average linear rates of sedimentation of ~0.6 cm/ky are relatively stable to ~148 m CSF-A. Between 148 and 149 m CSF-A, a ~3 million year-long interval from 50.5 to 53.7 Ma is recorded by a series of chert horizons. The lower Eocene to the PETM sequence accumulated at average linear sedimentation rates of ~1.4 cm/ky. Immediately underlying the PETM, a highly condensed chert-rich interval with at least one hiatus between 182 and 189 m CSF-A corresponds to ~56-62 Ma. Average linear sedimentation rates of ~0.8 cm/ky are recorded in the interval spanning the K-Pg boundary (~62-69 Ma).

Headspace gas analysis for the purpose of safety monitoring yielded low concentrations of methane that gradually increased to 17 ppmv with depth. Other higher hydrocarbon gases were not detected. TOC content was quite low in the upper 34 m of Hole U1403A, ranging from 0.14 to 0.46 wt %, except for the interval 27-31 m where TOC content ranged from 1.4 to 1.7 wt%. Carbonate content varied between 0.04 and 0.80 wt% in Cores U1403A-1H through 13H. In the bottom of Core U1403A-13H (~137 m) carbonate increases to 60% and fluctuates between about 2 and 40% to the bottom of the recovered sequence.

Grain density values are typically low (~1.5 g/cm^3) in lithologic Units I to IV that are dominated by clay and then increase to 1.6 g/cm^3 and gradually to 1.8 g/cm^3 in lithologic Unit V toward the deepest recovered sequences in the site. Porosity values are generally high (80%) in the radiolarian-rich sediments of lithologic Unit III and decrease (~60%) in the carbonate-rich section of lithologic Unit V. Magnetic

susceptibility (MS) falls from lithologic Unit I into the upper 18 m CSF-A of lithologic Unit II. Below 150 m CSF-A magnetic susceptibility shows large fluctuations between ~20 to values over 120 instrument units. These large amplitude increases in MS are linked with major events such as the ETM-2, PETM, K-Pg boundary and Campanian-Maastrichtian boundary. A further large amplitude MS peak was documented in Paleocene sediments at Site U1403. P-wave velocity increases progressively downhole in the upper 150 m CSF-A to 1550 m/s, takes a step to a velocity of 1600 m/s in the chert at the top of lithologic Unit V and continues to increase to ~1650 m/s at the bottom of the recovered section. NGR measurements average 30 cps until 110 m CSF-A, fall to 20 cps in the nannofossil clays of lithologic Unit VI, and then show high frequency fluctuations in carbonate sediments of lithologic Unit V.

At the conclusion of coring at 2200 h on 16 June, the hole was swept clean with 30 barrels of high viscosity mud and the drill string was pulled from the hole to 78.43 m DSF for logging with the triple combo string and FMS-Sonic string. Two attempts to deploy the logging tools failed and the tools became firmly stuck inside the BHA with ~17 m of the tool string extending out from the bit. After working the tools for several hours with no progress, the wireline was severed and the pipe tripped to the surface. When the tools arrived on the rig floor it was discovered that the triple combo tool string had parted, leaving ~17 m of tools missing from the bottom of the tool string, including the density and porosity tools.

A video and sonar survey was planned to find and recover the lost tools. During deployment, the camera was shaking, vibrating and rotating around the pipe due to strong ocean currents. At 2145 h, with the bit ~30 m above the seafloor, the signal from the subsea camera and the Mesotech Sonar were lost. The pipe was tripped back to the rig floor with the camera frame resting on top of the bit. Our suspicion that the co-axial cable supporting the camera system had failed was confirmed when the camera cable arrived at the rig floor.

Repair of the camera system would have taken 1-2 days, and redeployment was likely to result in the same problems. In addition, the potential loss of the only re-entry system available for this vessel would have been detrimental to future operations. The

decision not to deploy the camera system again at this site meant that we were unable to locate the lost logging tool or Hole U1403B. The drill floor was secured at 1415 h on 19 June, ending Site U1403 (JA-1A) and Hole U1403B.