

IODP Expedition 400: NW Greenland Glaciated Margin

Week 3 Report (27 August–2 September 2023)

Operations

This week we (1) cored two holes with the rotary core barrel (RCB) system, (2) completed three logging runs, and (3) cored two holes with the advanced piston corer (APC) and half-length advanced piston corer (HLAPC).

Hole U1603C

Week 3 of the expedition began with the vessel preparing to initiate Hole U1603C. Hole U1603C was spudded at 0105 h and the hole was drilled down over the next 7.75 hrs. Cores U1603C-2R to 9R advanced from 211.5 to 285.0 meters below seafloor (mbsf) and recovered 22.78 m (33%). At 1945 h on 27 August 2023 ice moved within 3 nmi of the vessel and we raised the drill string to 22.3 mbsf and began waiting on ice (WOI).

At 0000 h on 28 August, ice entered the 1 nmi exclusion zone. We raised the drill string, clearing the seafloor at 0009 h and ending Hole U1603C, and we continued WOI. The vessel was moved 1200 m east-northeast and then 700 m east-southeast in dynamic positioning (DP) mode to maintain a safe distance from the ice. By 0330 h the ice had cleared the site and the vessel was positioned 10 m northwest from Hole U1603C.

Hole U1603D

Hole U1603D was spudded at 0455 h on 28 August and, with a wash barrel, was drilled ahead to 102.0 mbsf. As ice once again neared the site, we decided to install a free-fall funnel (FFF) to allow us to Hole U1603D. The FFF was deployed at 0950 h, and by 1030 h we resumed drilling ahead in Hole U1603D to 189.0 mbsf. At 1400 h ice moved within 3 nmi of the vessel and we raised the drill string to 22.3 mbsf by 1515 h and began WOI for the remainder of the day.

By 0015 h on 29 August the ice had cleared the site. The drill string was lowered to 169.6 mbsf, and we washed back to 189.0 mbsf before drilling ahead to 269.4 mbsf. Cores U1603D-2R to 8R advanced from 269.4 to 333.2 mbsf and recovered 14.62 m (24%). At 1400 h ice moved within 3 nmi of the vessel and we raised the drill string to 22.3 mbsf by 1545 h and began WOI. Ice then entered the 1 nmi exclusion zone and we raised the drill string, clearing the seafloor at 1930 h. The vessel was moved 1000 m north in DP mode to maintain a safe distance from the ice. By 2157 h we began to move back toward the site and the vessel was in position over Hole U1603D by 2348 h on 29 August.

At 0100 h on 30 August we began preparing the subsea camera system to assist with reentering Hole U1603D. At 0320 h we successfully reentered the hole and recovered the subsea camera system. The drill string was lowered to 294.4 mbsf, and we washed back to 318.5 mbsf before

encountering material that had fallen into the bottom of the hole. A center bit was dropped and we washed to 333.2 mbsf by 0800 h. Cores U1603D-9R to 18R advanced from 333.2 to 422.0 mbsf and recovered 28.69 m (32%). Sepiolite (drilling mud) was swept in the hole and the bit was released at 2315 h to prepare for logging Hole U1603D. We then tripped the drill string up to 50.8 mbsf in preparation for logging.

The quad combo tool string was rigged up and, following a repair to the logging winch, was deployed to the base of Hole U1603D (419.5 mbsf). The quad combo measures natural gamma ray (NGR), acoustic velocity, resistivity, magnetic susceptibility (MS), and density. Following a complete pass of the hole the quad combo was pulled to the rig floor and broken down. The Versatile Seismic Imager (VSI) was rigged up and the protected species watch began at 1600 h on 31 August. The VSI was deployed but almost immediately experienced a communication issue. The tool was brought back onboard and repaired. At 1800 h the VSI was deployed to 413.1 mbsf and stations were measured up hole until 2120 h when fog impacted visibility and the ability to monitor for protected species. After the VSI tool was brought back onboard and broken down, the Formation MicroScanner (FMS)-sonic tool string was assembled and deployed. The FMS-sonic tool string was run and the tools were back on deck by 0345 h on 1 September. With logging completed we tripped the pipe out of Hole U1603D, clearing the rig floor at 0900 h and ending Hole U1603D.

Hole U1603E

An APC/extended core barrel (XCB) bottom-hole assembly (BHA) was made up and we began tripping the drill pipe back to the seafloor at 1200 h on 1 September. The vessel was offset 10 m northwest in DP mode and the pipe was pumped with a cleanout tool while the tracer pumps were running. Hole U1603E was spudded at 1745 h and Core U1603E-1H recovered 6.94 m. Core 2H advanced to 16.4 m and recovered 9.75 m (103%). Cores 3H through 6H each advanced 9.5 m but recovered almost no material (less than 20 cm each). The deplugger was run in the pipe. Core U1603E-7F advanced from 54.4 to 59.1 mbsf and recovered 0.31 m (7%). Following Core 7F we decided to abandon Hole U1603E due to lack of recovery and the drill string was tripped out, clearing the seafloor at 0140 h on 2 September.

Hole U1603F

The vessel was offset 10 m southeast of Hole U1603A and Hole U1603F was spudded at 0235 h on 2 September. Cores U1603F-1H to 5H advanced from 0 to 44.0 mbsf and recovered 45.49 m (103%). Core U1603F-6F (44.0–48.80 mbsf; 4.73 m recovered) was cored with the HLAPC system to help adjust core spacing to cover gaps in Hole U1603A. Cores U1603F-7H to 15H advanced from 48.8 to 134.3 mbsf and recovered 66.71 m (78%). We then began pulling the drill string out of the hole, clearing the seafloor at 1935 h. The week ended with the APC/XCB BHA being disassembled.

Science Results

Site U1603

Science activities during the week included the processing and measurement of core sections and shipboard samples for Site U1603. The science party also worked on reports for Site U1603.

Lithostratigraphy

All cores from Holes U1603C, U1603D, U1603E, and the majority of Hole U1603F were split and described. At Site U1603, four main lithofacies were identified based on lithology, sedimentary structures, textures, and other common characteristics: mud, calcareous mud, interlaminated to interbedded mud and sand, and diamicton with sandy mud and common clasts. These lithofacies are present throughout the succession with variable predominance. Sediments recovered are consistent with the site location at the base of the continental slope proximal to a glaciated margin deposited during the Early to Late Pleistocene. Significant downhole changes in lithology, identified using a combination of visual core description, microscopic characterization (via smear slides, grain mounts, and thin sections), reflectance spectroscopy and colorimetry, and bulk and clay mineralogical analysis by X-ray diffraction, were used to begin dividing the succession at Site U1603 into lithostratigraphic units.

Biostratigraphy

The Micropaleontology group has processed and examined samples from core catcher and other discrete samples from Holes U1603A, U1603B, U1603C, U1603D, and U1603F for foraminifer, dinoflagellate, and diatom biostratigraphic markers. Coiling counts on the samples with abundant *Neogloboquadrina pachyderma* were also conducted. Species identifications of benthic foraminifers observed in the samples were made and dinoflagellates were found in the majority of samples. Some species of dinoflagellate might reflect reworked Paleogene sediments. Diatoms are visually barren in most of the samples observed with the exception of 6 samples which contained trace to rare amounts of *Coscinodiscus marginatus*, *C. oculus-iridis* and *Melosira arctica* (high latitude species), and a few specimens of *Stephanopyxis turris* and *Podosira* sp.

Paleomagnetism

Archive half sections of cores from Holes U1603B, U1603C, U1603D, U1603E, and U1603F were measured on the superconducting rock magnetometer (SRM). Discrete cube samples were collected from most sections of cores from Holes U1603C and U1603D. The natural remanent magnetization (NRM) and remanent magnetization after alternating field (AF) demagnetization up to 80 mT of a subset of discrete cube samples were measured on the spinner magnetometer, and another subset of samples on the SRM. The rest of the discrete samples were measured (NRM and after demagnetization up to a peak AF of 20 mT) on the SRM. Anisotropic MS and bulk susceptibility were measured on all discrete samples. Anhysteretic remanent magnetization

was also measured on a subset of discrete samples. The Brunhes-Matuyama boundary was observed in Hole U1603B.

Geochemistry

Processing of whole-round core samples for interstitial water (IW) and headspace void gas samples for gas analysis continued across Holes U1603B, U1603C, and U1603D. IW samples were collected at a resolution of one per core, and headspace gas sampling was continued at half core resolution depending on core recovery. Methane concentrations in Holes U1603C and U1603D remain high (>10,000 ppm). Ethane concentrations are up to 14 ppm, with methane/ethane ratios (C1/C2) of 1,948–22,688 reflecting hydrocarbon gas production from biogenic sources. Analyses of solid phases for carbonate content using the shipboard coulometer reveal CaCO₃ content of 1% or less throughout most intervals; however, CaCO₃ content is much greater (up to 58%) in calcareous mud intervals. Analyses of total carbon and nitrogen continued. High-resolution Rhizon sampling for IW was completed for the upper 15 m of Hole U1603E. Samples for sedimentary ancient DNA (sedaDNA) were collected on the catwalk and on selected working half sections immediately after splitting.

Physical Properties

Whole-round sections of Holes U1603C and U1603D were logged on the Natural Gamma Radiation Logger (NGRL) as soon as they arrived in the laboratory, following by logging on the Whole-Round Multisensor Logger (WRMSL) once equilibrated to room temperature (~19°C). *P*-wave velocity (PWL), MS, and gamma ray attenuation (GRA) bulk density were logged at 2 cm resolution. Thermal conductivity was measured on one section per core. When possible, the data were obtained on the whole-round section; however, lithology warranted thermal conductivity measurements on half-sections for a number of cores. Whole-round sections of Holes U1603E and U1603F were logged on the NGRL and the WRMSL as they arrived in the laboratory. The logging on the WRMSL was limited to MS measured at 5 cm resolution for correlation purposes. GRA was blocked to avoid any possible effect of the gamma radiation to the sedaDNA samples from section halves. PWL velocity does not provide comparable results if the core is not at room temperature thus it was also disconnected. X-ray images were collected for all archive section halves on the X-SCAN imager. Discrete *P*-wave velocity measurements (2–3 per core in Holes U1603C and U1603D and every section in Holes U1603E and U1603F) were done using the *P*-wave caliper (PWC). In addition, moisture and density (MAD) samples (2 per core) were taken on cores from Holes U1603C and U1603D to determine wet and dry bulk density, grain density, water content, and porosity. In general, NGR values oscillate from a relatively constant baseline. Average MS decreases downhole in Holes U1603C and U1603D, as well as the measured bulk density values from GRA and MAD, which correlate fairly well. *P*-wave velocities increase deeper in the site.

Downhole Measurements

Downhole logging was conducted in Hole U1603D. Hole stability, a lack of icebergs, and favorable weather conditions allowed for three runs of downhole logging expanded over a continuous 16 h period. The first run included a modified triple combo tool string (quad combo). The quad combo measures NGR, acoustic velocity, resistivity, MS, and density. This was followed by the VSI and the observation for protected species was in place before and during seismic shooting. Unfortunately, there were problems with anchoring the tool against the borehole wall, and this combined with decreased visibility required for protected species observations resulted in abandoning VSI logging. The third run included the FMS-sonic tool string. All runs were implemented to nearly 2 m from the bottom of the hole and the preliminary assessment of the data shows high quality on the quad combo and FMS acquisition. Logs have been sent to Lamont-Doherty Earth Observatory (LDEO) for further processing.

Stratigraphic Correlation

Stratigraphic correlation is not possible on RCB cores; however, an effort to tie Holes U1603B, U1603C, and U1603D together was made. Ties between the lower cores of Hole U1603B and the upper cores of Hole U1603C are based on physical properties and lithological similarities. A tie between Holes U1603C and U1603D was not reliable, and the recovery gaps seem to align between the two holes. A coring strategy to capture gaps in Holes U1603A and U1603B was designed for Hole U1603E and revised for Hole U1603F. Cores from Holes U1603E and U1603F were logged for NGR and MS immediately upon arrival in the laboratory to allow for updates to the coring plan to cover gaps from previous holes. Gaps between cores in Hole U1603A were covered by those obtained in Hole U1603F. Overall, the recovery of both Holes U1603A and U1603F, complemented with Hole U1603E, produced a complete stratigraphic section of the upper 78 m CCSF-A of the sedimentary record.

Outreach

The following outreach activities took place during Week 3.

A logbook about life aboard the *JOIDES Resolution* for Reach The World was posted and 19 schools are currently following Expedition 400, which is currently the featured expedition on the Reach The World homepage. A blog post about onboard baker Albert was posted to the *JOIDES Resolution* website, along with a complementary “Discovery on Deck” YouTube short video. An open house was held on 30 August with an estimated 100–140 people in attendance. The event was recorded and will be posted to the *JOIDES Resolution* YouTube channel. Outreach Officers scheduled several upcoming tours and assisted Georgia Grant (New Zealand), Sandrine Le Houdec (Switzerland), and Libby Ives (USA) with broadcasts and video production for their home institutions.

Social Media

Group	No. of posts	Analytics	Notes
Facebook	3	2 new followers Post reach: 7,000 Post reactions & likes: 164 Avg Post engagement: 5.41% Post shares: 26	Top post: STEM SEAS. 60 reactions (post by USSSP)
Instagram	5	8 new followers Post Reach: 5,100 Post Impressions: 3,400 Post reactions & likes: 349 Avg Post engagement: 8.71%	Top post: Catwalk Science-Paleogeneticist. 89 Likes
Twitter	8	19 new followers Post impressions: 21,000 Post reactions & likes: 216 Avg Post engagement: 3.14% Re-tweets: 43	Top Post: @seattlemkh-That completely makes sense! (post by USSSP), 13.33% engagement

Ship-to-Shore Broadcasts

Group	No. of people	Notes
LaFayette High School	~15–20	
Maitland University of the 3rd Age (Australia)	15	Hosted on shore by Bob Musgrave.
Open House	~ 100–140	Many friends and family of scientists and crew onboard attended. The event was enthusiastically received.

Technical Support and HSE Activities

The following technical support activities took place during Week 3.

Laboratory Activities

- Technical staff fully engaged in core processing and science support for Holes U1603C–U1603F.
- Logged Hole U1603D and performed protected species observations in conjunction with the vertical seismic profile (VSP) operation.
- Testing of the latest version of a stand-alone X-ray image processing application.
- Replaced a leaking steam tap on the Espresso Machine. No science was lost during the machine downtime.
- The scale bar in Image Capture was calibrated for each microscope after it was found they were incorrect.

Application Support Activities

- GEODESC development and maintenance was conducted.
- Minor changes were made to the LIVE data display.
- A fix for the coulometer software was deployed to prevent the instrument from timing out early.
- Provided a fix for a bug in the Sample and Data Request Management (SDRM) system discovered on shore.
- Tested IRIS modifications with the Operations Superintendent and investigated and researched the functionalities that require additional work.
- Researched and investigated the IMS application for use with the hyperspectral logger project.
- Performed database maintenance as requested from shore.

IT Support Activities

- Started the rollout of the WifiGem application to all Expedition 400 participants and allowed users to sign up on demand for Starlink internet access when ready.
- The Starlink satellite internet has been very reliable so far, based on initial usage feedback.
- Working with the Extreme support team to troubleshoot our video distribution units, which are having trouble playing the ship's video streams on the Bridge Deck.

HSE Activities

- Emergency shower and eyewash stations were tested.
- An abandon ship drill was held on 27 August at 1300 h.