

## **IODP Expedition 400: NW Greenland Glaciated Margin**

### **Week 4 Report (3–9 September 2023)**

#### **Operations**

This week we (1) cored two holes with the advanced piston corer/extended core barrel (APC/XCB) and half-length advanced piston corer (HLAPC) and (2) completed two logging runs.

##### *Hole U1603F*

Week 4 of the expedition began with the APC/XCB bottom-hole assembly (BHA) from Hole U1603F being disassembled. The drill string was tripped up, with the bit at the surface at 0030 h on 3 September 2023. The drill floor was secured for transit and the thrusters were raised and secured for transit at 0145 h, ending Hole U1603F and Site U1603.

##### *Hole U1604A*

The vessel transited 16 nmi to proposed Site MB-02C (Site U1604), arriving on location at 0306 h on 3 September. The thrusters were lowered and secured at 0324 h and the ship was fully in dynamic positioning (DP) mode at 0337 h. The rig crew made up an APC/XCB BHA and began tripping the drill pipe. Hole U1604A was spudded at 1020 h and Core U1604A-1H recovered 2.04 m. The seafloor was calculated as 1942.2 meters below sea level (mbsl). Cores U1604A-1H to 26H advanced from 0 to 206.8 meters below seafloor (mbsf) and recovered 195.34 m (96%). Formation temperature measurements were made on Cores 4H, 7H, 10H, and 13H.

We switched to the HLAPC coring system; however, Core U1604A-27F only recovered 2.85 m after a partial stroke. We then switched to the XCB coring system and Cores U1604-28X to 30X advanced from 209.6 to 233.0 mbsf and recovered 23.71 m (103%). At 1930 h on 4 September ice moved within 3 nmi of the vessel and we raised the drill string to 16.2 mbsf by 2045 h and began waiting on ice (WOI). By 2300 h the ice had moved a sufficient distance away from the vessel and we began to lower the drill string back into Hole U1604A.

Hole U1604A was washed back to 233.0 mbsf by 0100 h on 5 September. Cores U1604A-31X to 32X advanced from 233.0 to 250.6 mbsf and recovered 11.05 m (63%). At 0430 h ice moved within 3 nmi of the vessel and we raised the drill string to 16.7 mbsf by 0545 h and began WOI. Ice then entered the 1 nmi exclusion zone and we raised the drill string, clearing the seafloor at 0715 h, ending Hole U1604A. The vessel was moved 700 m north and then 700 m west to maintain a safe distance from the ice.

### *Hole U1604B*

By 1600 h on 5 September we began to move back toward the site and the vessel was in position over Hole U1604B (20 m northeast of Hole U1604A) by 1630 h. Hole U1604B was spudded at 1755 h and the seafloor was established as 1943.6 mbsl. Cores U1604B-1H to 14H advanced from 0 to 105.3 mbsf and recovered 98.14 m (93%). However, Core 14H only recovered 0.2 m of material. An XCB core barrel was dropped and Core 15X advanced from 105.3 to 105.5 mbsf and recovered 0.22 m of hard material. We then switched back to APC coring and Cores 16H to 22H advanced from 105.5 to 163.1 mbsf and recovered 59.68 m (103%). Cores 21H and 22H were only partial strokes so we switched to the HLAPC system for Core 23F which advanced from 163.1 to 167.9 mbsf and recovered 4.78 m (100%). We switched back to APC coring and Cores 24H to 30H advanced from 167.9 to 216.8 mbsf and recovered 49.87 m (102%). We then switched to the HLAPC coring system and Cores U1604B-31F to 35F advanced from 216.8 to 237.6 mbsf and recovered 16.89 m (83%). With ice still in the general area we decided to install a free-fall funnel (FFF) to allow us to complete coring and logging of the site in Hole U1604B. The FFF was deployed at 1530 h on 7 September and by 1630 h we resumed coring Hole U1604B. Cores U1604B-36X to 55X advanced from 237.6 to 429.6 mbsf and recovered 88.25 m (46%).

Sepiolite (drilling mud) was swept into the hole and heavy barite mud was added in preparation for logging Hole U1604B. The drill string was tripped up and the end of pipe set at 58.7 mbsf. The quad combo tool string was rigged up by 0100 h on 9 September and deployed to the base of Hole U1604B. Following a complete pass of the hole the quad combo was pulled to the rig floor and broken down. The Formation MicroScanner (FMS; without sonic) tool was then assembled and deployed at 0640 h. The FMS was run and the tools were back on deck by 1200 h. With logging completed we tripped the pipe out of Hole U1604B, clearing the rig floor at 1720 h. The drill floor was secured for transit and the thrusters were raised and secured for transit at 1824 h, ending Hole U1604B and Site U1604.

### *Hole U1605A*

The vessel transited 39 nmi to proposed Site MB-31A (Site U1605), arriving on location at 2200 h on 9 September. Observing that ice was a sufficient distance away from the vessel, the thrusters were lowered and secured at 2224 h and the ship was fully in DP mode at 2229 h. The precision depth recorder (PDR) calculated the seafloor at 535.4 mbsl and we ended the week preparing to trip pipe for Hole U1605A.

## Science Results

### *Sites U1603 and U1604*

Science activities during the week included the processing and measurement of core sections and shipboard samples for Site U1604. The science party also worked on reports for Site U1603 and gave site summary presentations.

### *Lithostratigraphy*

At Site U1604, six main lithofacies were identified based on lithology, sedimentary structures, textural, and other common characteristics: massive mud, weakly stratified mud (including bioturbated mud), calcareous mud, laminated mud (including rare ripple cross-lamination), interlaminated mud and sand, and gravel-bearing sediment (diamicton, mud with common to abundant clasts, muddy sand with common to abundant clasts, and sandy mud with common to abundant clasts). These lithofacies are present throughout Site U1604 in 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 (RSC), and bulk and clay mineralogical analysis by X-ray diffraction (XRD), were used to begin dividing the succession at Site U1604 into lithostratigraphic units.

### *Biostratigraphy*

The Micropaleontologists processed and observed 54 core catcher samples from Holes U1604A and U1604B. Micropaleontological sampling began for Hole U1604B in Section 36X-CC (every other core catcher section was sampled for palynology). More than 30 discrete samples from the working half sections and 38 smear slide samples were also processed and examined for foraminifers, dinoflagellate cysts, and diatoms. Additional clast sampling was performed for reworked palynomorphs. Targeted discrete and smear slide samples were collected on intervals characterized by more massive muds associated with lows in natural gamma radiation (NGR) and magnetic susceptibility (MS). Throughout Holes U1604A and U1604B, calcareous mud and gravel-bearing sediment lithofacies were used to guide additional micropaleontological sampling. In general, Site U1604 sediments are scarce of microfossils. Only a few samples were found with trace to rare microfossil abundance. In addition, a total of 110 samples for sedimentary ancient DNA (sedaDNA) analysis and one mudline sample were collected from Hole U1604B.

### *Paleomagnetism*

Archive half sections of cores from Holes U1604A and U1604B were measured on the superconducting rock magnetometer (SRM). Discrete cube samples were collected from Holes

U1604A and U1604B in intervals where new material was recovered. A subset of discrete cube samples was measured after alternating field (AF) demagnetization on the JR-6A spinner magnetometer as well, after applying an anhysteretic remanent magnetization. Anisotropy magnetic susceptibility (AMS) and bulk susceptibility were measured on all discrete samples. The Brunhes/Matuyama boundary is tentatively identified at similar depths in Holes U1604A and U1604B.

### *Geochemistry*

Processing of whole-round core samples for interstitial water (IW) and headspace void gas samples for gas analysis continued across Holes U1604A and U1604B. IW samples were collected at a resolution of one per core, and two headspace gas samples were taken per core. Methane concentrations in Hole U1604A were low (<10 ppm) down to a depth of ~200 mbsf and gradually increased to values up to 30,000 ppm around 250 mbsf (Hole U1604B), with ethane concentrations up to 4 ppm. Below 320 mbsf, concentrations of both gases decreased gradually, approaching values mostly below 10,000 ppm at 350 mbsf and below. The methane/ethane ratios (C1/C2) were high and remained between 8,000 and 30,000 throughout all samples analyzed. Measurements of pH and alkalinity in IW from Site U1604 were performed in near real time. Interstitial waters from Site U1604 were analyzed for anions and cations (ion chromatograph), ammonium and phosphate concentration (spectrophotometer), and elemental concentrations inductively coupled plasma–atomic emission spectrometry (ICP-AES). Potassium and magnesium show general decreases downcore, while barium and strontium show overall increases. Sulfate decreases downhole to approximately 150 mbsf depth. Ammonium reaches a maximum at approximately 100 mbsf, then decreases with depth. Phosphate reaches a maximum within the upper 15 m, then remains constant at approximately 7–10  $\mu\text{m}$ . Sampling carbonate analyses was carried out at a resolution of 2–4 samples per core, depending on lithological variation. Analyses of total carbon and nitrogen are ongoing. High-resolution Rhizon sampling for IW was completed for the upper 20 m of Hole U1604B.

### *Physical Properties*

Whole-round sections of Hole U1604A were logged on the Natural Gamma Radiation Logger (NGRL) as soon as they arrived in the laboratory, followed 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 section halves for several cores. Whole-round sections of Hole U1604B 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 planned sedaDNA samples. PWL velocity does not provide comparable results without equilibration to room temperature, thus, it was also disconnected. Below ~250 mbsf sections of Hole U1604B followed the exact

same protocol as those from Hole U1604A. X-ray images were collected for all archive section halves on the X-Ray Linescan Logger (XSCAN). Discrete *P*-wave velocity measurements were done using the *P*-wave caliper (2–3 per core in Hole U1604A and below 250 mbsf in Hole U1604B; every section in the upper 250 m of Hole U1604B). In addition, moisture and density (MAD) samples (2 per core) were taken on cores from Holes U1604A and below 250 mbsf in Hole U1604B to determine wet and dry bulk density, grain density, water content, and porosity. In general, NGR and MS values present a slight increasing trend downhole. *P*-wave velocities increase downhole.

### *Downhole Measurements*

Downhole logging was conducted in Hole U1604B. 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 a second run with the FMS tool. The logging was completed in ~10 h. Data were collected from the base of the drill string (58.7 mbsf) to ~3 m above the base of the hole, and the preliminary assessment of the data shows high quality. Logs of Hole U1604B were sent to Lamont-Doherty Earth Observatory (LDEO) for further processing.

### *Stratigraphic Correlation*

Cores from Hole U1604B were logged for NGR and MS at arrival at the laboratory to allow for updates to the coring plan to cover gaps from Hole U1604A. However, intervals with low recovery prevented a complete correlation between the two holes. Further efforts on the stratigraphic correlation of Site U1603 were done this week. A preliminary splice of the upper ~98 m composite core depth below seafloor, method A (CCSF-A) of Site U1603 were distributed among the science party for further feedback.

## **Outreach**

The following outreach activities took place during Week 4.

We hosted a live ship-to-shore event with Reach The World, which was live streamed using Streamyard, which allowed the event to be simulcast on Reach The World platforms, as well as the *JOIDES Resolution* (JR) YouTube channel. A Science Objectives presentation was finalized, will be shared with relevant tour requestors, and will be posted on the [www.joidesresolution.org](http://www.joidesresolution.org) expedition webpage.

*Social Media*

<b>Group</b>	<b>No. of posts</b>	<b>Analytics</b>	<b>Notes</b>
<a href="#">Facebook</a>	12	5 new followers Post reactions & likes: 264 Post Impressions: 13,000 Avg Post engagement: 6.15% Post shares: 34	Top post: Protected species watch (54 reactions)
<a href="#">Instagram</a>	8	10 new followers Post reactions & likes: 612 Post Impressions: 4,900 Avg Post engagement: 11.01%	Top post: Scientists are naturally curious (128 likes)
<a href="#">Twitter</a>	18	12 new followers Post reactions & likes: 317 Post impressions: 24,000 Avg Post engagement: 3.12% Re-tweets: 36	Top Post: Earth's magnetic polarity 7.64%

Ship-to-Shore Broadcasts

<b>Group</b>	<b>No. of people</b>	<b>Notes</b>
Colorado State University, Intro to Oceanography	~300	Undergraduate students; colleague of Anne Jennings
Colorado State University, Coastal Environmental	~30	Undergraduate students; colleague of Anne Jennings
Arapohue School, New Zealand	9	Former school and students of Michelle Pratt. Georgia Grant (NZ) co-presented
Reach The World (RTW) - Livestream Event #2	~60-500	19 classes and almost 500 students are registered, but live event attendance is not known. 183 views on RTW YouTube and 79 views on JR YouTube
Legg Middle School	30	Career focused tour

Gruening Middle School, Alaska	300	7th graders; former middle school of Michelle Pratt
China: Girls in Science Event	Unknown	Three female scientists onboard shared about their careers and onboard science

## Technical Support and HSE Activities

The following technical support activities took place during Week 4.

### *Laboratory Activities*

- Technical staff fully engaged in core processing and science support at Holes U1604A and U1604B. Downhole logging was conducted at Hole U1604B.
- Continued testing of the latest version of a stand-alone X-ray image processing application.

### *Application Support Activities*

- Fixed a defect in IMS that prevented a section from being processed on the tracks.
- GEODESC maintenance was conducted.
- Resolved an issue with MUT on the SRM (failed to upload measurements for certain standards).
- Investigated other minor ongoing MUT issues.
- Continued IRIS development.
- Assisted with Drill Report issues.
- Fixed a bug in the Sample, Data, and Research Request Manager (SDRM) application.
- Resolved an issue with LORE not sorting chemistry reports properly.
- Assisted with correlation issues (splice/affine uploading).

### *IT Support Activities*

- Worked with the Extreme support team to troubleshoot the video distribution units on the Bridge Deck. Expecting to perform multiple extended remote sessions until this issue is resolved.
- Continued routine Marine Computer Specialist (MCS) tasks. This includes updating servers, workstations, and daily-use software/programs.
- Experienced some issues with the WifiGem Captive Portal, however, most have been resolved.

- We saw an increase in users having login issues when trying to access the captive portal. WifiGem support is working to deliver some feature updates that will help us provide better support for our users.
- Starlink satellite internet remains fairly reliable with minimal internet interruptions.
- Worked on developing a GUI Application version of DriveMapper for Windows.

#### *HSE Activities*

- Emergency shower and eyewash stations were tested.
- While testing an eyewash station, the water was found to be hot. The incident was reported, and the issue was resolved by the engineering department.
- An abandon ship drill was held at 1300 h on 3 September.