

IODP Expedition 403: Eastern Fram Strait Paleo-Archive

Week 3 Report (16–22 June 2024)

Operations

Hole U1618A

Week 3 began at Hole U1618A with coring using the extended core barrel (XCB) from a depth of 228.3 to 276.9 meters below seafloor (mbsf). C₁/C₂ gas headspace ratios were monitored and were in the anomalous zone at 276.9 mbsf. Hole U1618A was terminated, and the gas, temperature, and core data were sent to shore for feedback from the Environmental Protection and Safety Panel (EPSP) to determine if coring any deeper at the site could be done in a safe manner. The top drive was set back, and the bit was pulled out of the hole, clearing the seafloor at 1043 h on 16 June 2024. The vessel was then offset 50 m at 139° to begin operations at Hole U1618B.

A total of 37 cores were taken in Hole U1618A over a 276.9 m interval with 252.62 m of recovery (91%). The advanced piston corer (APC) was used for 11 cores over a 94.0 m interval with 90.07 m recovered (96%). The half-length APC (HLAPC) was deployed for 13 cores over a 56.8 m interval with 60.18 m recovered (106%), and the XCB was deployed for 13 cores over a 126.1 m interval with 102.37 m recovered (81.2%). All APC and HLAPC cores were taken using nonmagnetic core barrels. Temperature measurements were taken on Cores U1618A-4H, 7H, 10H, and 13F using the third-generation advanced piston corer temperature (APCT-3) tool. A fifth temperature measurement was taken using the Sediment Temperature 2 (SET2) probe after Core U1618A-34X at a depth of 249.0 mbsf. In total we spent 48.50 h (2.1 d) at Hole U1618A.

Hole U1618B

The vessel was offset 50 m from Hole U1618A at 139° to begin operations at Hole U1618B. A depth reading was taken using the precision depth recorder, estimating the seafloor at 1190.0 meters below sea level (mbsl). The top drive was picked up and the bit was placed at 1189 mbsl for the mudline core. Hole U1618B was spudded at 1245 h on 16 June. The seafloor was calculated at 1195.2 mbsl, based on recovery from Core U1618B-1H.

Coring continued with the APC from Core 1H to 13H to a depth of 112.8 mbsf. Partial strokes were recorded for Cores U1618B-6H, 8H, and 13H. A shattered liner on Core U1618B-7H required that the core be pumped out of the core barrel.

The HLAPC was deployed for Core U1618B-14F, from 112.8 to 117.5 mbsf. The decision was made to revert to the APC system for Core U1618B-15H. This core was a partial stroke and only advanced from 117.5 to 117.7 mbsf, signaling APC refusal had been reached. Permission was

received from EPSP to deepen Hole U1618B past the total depth of Hole U1618A (276.9 mbsf), as long as the headspace C_1/C_2 ratios in this hole remained normal. The hole was advanced with the XCB coring system for Cores U1618B-16X to 54X, deepening the hole from 117.5 mbsf to the total depth of 414.3 mbsf. At that depth, the C_1/C_2 ratio jumped sharply into the anomalous zone causing coring to be terminated at 1300 h on 19 June. It was decided to attempt downhole wireline logging in Hole U1618B instead of Hole U1618C.

A total of 54 cores were taken in Hole U1618B over a 414.3 m interval with 375.24 m recovered (100%). The APC was used for 14 cores over a 113.0 m interval with 112.48 m recovered (100%). The HLAPC was deployed for one core over a 4.7 m interval with 1.63 m recovered (35%). Finally, the XCB was deployed for 39 cores over a 296.6 m interval with 261.13 m recovered (88%).

All cores collected with the APC and HLAPC systems were taken using nonmagnetic core barrels. Two temperature measurements were attempted using the SET2 temperature probe. The first, after Core U1618B-40X, returned with no data. The second attempt after Core U1618B-41X returned a good temperature reading from a depth of 325.0 mbsf.

The bit was pulled to a depth of 68.6 mbsl and the Schlumberger wireline was rigged up. The triple combo logging tool string was made up and deployed at 1645 h on 19 June, reaching a depth of 373.3 mbsf on the first pass and 368.3 mbsf on the second. The tools were recovered, and the Formation MicroScanner (FMS)-sonic logging tool string was made up and deployed at 0300 h on 20 June. The tools reached a depth of 358.8 mbsf on the first pass and 342.8 mbsf on the second. The tools were recovered to the surface and the Versatile Seismic Imager (VSI) tool string was made up and deployed at 0445 h on 20 June. While running in with the tool, it was noticed that the z -axis was not transmitting data. The tools were recovered and the backup VSI tool was made up and deployed. While powering up the backup tool, a power surge caused a failure in the electronics. With both VSI tool strings inoperable, it was decided to end logging operations for the hole. The Schlumberger equipment was rigged down and the rig floor was cleared. The bit was pulled out of the hole, clearing the seafloor at 0740 h on 20 June, ending Hole U1618B. In total we spent 93.0 h (3.9 d) at Hole U1618B.

Hole U1618C

The vessel was offset 25 m to the northwest at a bearing of 319° from Hole U1618B, and the bit was lowered to 1194 mbsl. An APC core barrel was deployed and Hole U1618C was spudded at 1012 h on 20 June. The seafloor was calculated at 1195.8 mbsl based on recovery from Core U1618C-1H. Coring using the APC continued from Core 1H to 12H, to a depth of 91.7 mbsf, with partial strokes recorded on Cores 4H, 5H, and 8H–12H. The APC and HLAPC systems were deployed from 91.7 to 125.6 mbsf (13F–19H), with one drilled interval (161) from 107.9 to 109.9 mbsf. Partial strokes were recorded on Cores 14H and 19H.

The XCB coring system was deployed to extend the hole from 125.6 mbsf to the total depth of 392.1 mbsf (Cores 20X–59X) at 0000 h on 23 June. Advances of 7.0 to 7.5 m were used on the majority of the XCB cores to allow for gas expansion within the core liner.

Science Results

Lithostratigraphy

The sedimentology group described Cores U1618A-32X to 37X, U1618B-1H to 54X, and U1618C-1H to 55X. The lithologies encountered at Site U1618 are predominantly dark to very dark gray silty clays and clayey silts with occasional interbedded layers of sandy silt and sandy mud that might be indicative of paleoglacial melting events and/or turbidite deposits. Clasts are present in some cores, with grain sizes ranging from coarse sand to gravel. In addition, a few clasts were identified that are preliminarily interpreted as authigenic carbonates. X-ray diffraction (XRD) samples have been taken on these clasts and are currently being analyzed. All described cores were imaged with the Section Half Imaging Logger (SHIL) and were scanned with the Section Half Multisensor Logger. In addition, section half X-radiographs were taken for all described cores from Holes U1618B and U1618C with the X-Ray Linescan Logger. Taking into account visual core descriptions, X-radiographs, and physical properties, the sediments of Holes U1618A–U1618C were tentatively divided into three main units and five subunits. Unit I (IA and IB) consists of silty clay and possible turbidite intervals, Unit II consists of silty clay with more dominant voids and fractures due to gas, and Unit III (IIIA, IIIB, and IIIC) consists of silty clays and clayey silts with more dominant, coarser intervals than in the units above.

Biostratigraphy

The investigation of core catcher (CC) samples from Hole U1618B began at Core 35X, where the hole depth was deeper than that of Hole U1618A. No CC samples were analyzed from Hole U1618C. All CC samples were analyzed for calcareous nannofossils, foraminifers, and diatoms. Nannofossils abundance ranged from barren and rare to common, diatoms ranged from mostly barren to very rare, and all samples were barren of foraminifers. In addition, a systematic sampling of a minimum of 1–2 samples per core were analyzed for nannofossils and diatoms groups from working halves of Holes U1618B and U1618C (84 samples). Selected CC samples and targeted levels in working halves were analyzed for dinocysts. Only fragments of diatoms are found in the samples from Hole U1618B. The analysis of nannofossils in Hole U1618B allowed for the identification of three biostratigraphic boundaries between the early to late Pleistocene. The overall structure of nannofossil assemblages is in agreement in all holes of Site U1618.

Paleomagnetism

Paleomagnetic and rock magnetic investigation of discrete cube samples and archive half sections continued for Site U1618. In Holes U1618A, U1618B, and U1618C, the reverse Matuyama Chron (>773 ka) could be identified; however, inclination data are noisy below this boundary. The paleomagnetism group discovered clasts with strong magnetic properties. XRD analysis identified that some of these clasts are composed of more than 90% greigite. Magnetic analyses indicate they are resistant to alternating field demagnetization. Anhysteretic remanent magnetization analysis of discrete cube samples indicate that sediments with similar magnetic properties are common and likely contribute to complication in identifying polarity zones to establish Site U1618's magnetic stratigraphy. Ongoing work seeks to compare detailed demagnetization of the sediment's natural remanent magnetization and rock magnetic properties to assess the reliability of collected paleomagnetic data.

Geochemistry

In Hole U1618B, interstitial water (IW) measurements resumed once we exceeded the maximum depth of Hole U1618A. In Hole U1618B, salinity values are decreasing downcore, while alkalinity and pH remain relatively stable. The geochemistry group continued to run carbonate analyses and began to compare their results to abundances of calcareous microfossils identified by the biostratigraphy group. In addition, the carbonate analyses were compared to XRD results to tease out the respective contributions of biogenic versus inorganic carbonates. Ca values reach a minimum of 4 mM at about 50 mbsf and they increase linearly below that depth toward 15 mM at the bottom of Hole U1618B. Both Mg and K concentrations decrease linearly from the seafloor toward the bottom of each hole. IW samples show a constant decrease in salinity from 34 PSU at the top, in good agreement to ambient seawater, down to about 22 PSU at the bottom of Hole U1618C. Headspace gas measurements were resumed from Core U1618B-23X, and C_1/C_2 ratios were constantly monitored. Plotted ratios began appearing outside of our safety envelope in Cores 53X and Core 54X. Thus, the decision was made to end Hole U1618B. Headspace analyses were conducted throughout all of Hole U1618C.

Physical Properties

The physical properties team measured gamma ray attenuation (GRA) bulk density, magnetic susceptibility (MS), P -wave velocity, and natural gamma radiation (NGR) on whole-round core sections from Holes U1618B and U1618C. Sampling for moisture and density analyses and thermal conductivity measurements continued in the deeper cores of Hole U1618B and the cores from Hole U1618C that filled in coring gaps from earlier holes. As cores were brought on board, sections were immediately measured for MS and GRA using the Special Task Multisensor Logger (STMSL). After sections thermally equilibrated for a minimum of 4 h, they were measured for GRA, MS, and P -wave velocity on the Whole-Round Multisensor Logger (WRMSL) track and then for NGR using the Natural Gamma Radiation Logger (NGRL). Cores

U1618C-1H to 3H were sampled for ancient DNA and were thus not scanned for GRA in order to avoid exposure of DNA to the radioactive cesium source. NGR and GRA records are in good agreement for Holes U1618A and U1618B, as well as for the upper part of Hole U1618C. MS in all holes is considerably noisy, probably due to the presence of greigite as described above in the paleomagnetism section. Whole-round and discrete *P*-wave velocities were measured using the Section Half Measurement Gantry for the upper cores of Hole U1618C until noisy data caused us to abandon the measurements. For all holes, *P*-wave values are very noisy, probably due to the presence of gas and/or ice-rafted debris clasts. Three whole-round samples with 10 cm length from Holes U1618B and U1618C were measured. After attaching 16 strain gauges with glue, samples were connected to a data logger to record anelastic strain recovery. The experiment will last at least one week for each sample.

Downhole temperature measurements from Hole U1618A were complemented by measurements in Hole U1618B. Preliminary interpretations of our measurements indicate that the geothermal gradient might be slightly shallower than in other regions. In addition, downhole logging was carried out at Hole U1618B using the triple combo and FMS-sonic tool strings for in situ density, porosity, MS, NGR, electrical resistivity, acoustic velocity, and borehole images. The VSI was rigged up and deployed; however, an electronic failure in the tool led to a loss of the *z*-axis signal, rendering the tool unusable. The VSI was recovered and a second VSI tool was rigged up. This tool experienced an electronics failure and was unable to be deployed. At the end of the week, the Downhole Measurements Specialist is waiting for the processed logging data to be interpreted in detail.

Stratigraphic Correlation

Correlation between Holes U1618A, U1618B, and U1618C was accomplished using MS and GRA density obtained from the STMSL soon after recovery. Initial correlation based on these data was used to monitor the coring breaks and to aid drillers in coring operations. After completion of Hole U1618C, the Stratigraphic Correlators started constructing the composite depth (CCSF-A) scale and a spliced stratigraphic section based on data sets of MS and GRA acquired from the WRMSL, digitized color data (channel R) extracted from core images acquired from the SHIL, and NGR data from the NGRL. At Site U1618, core correlation is challenging because of coring gaps due to incomplete recovery, core disturbance, gas expansion, and lateral thickness variability of coarse-grained layers.

Microbiology

This week the microbiologists took sedaDNA samples at Hole U1618B at low resolution on the catwalk (one sample per core), and at high resolution (~three samples per section for the first three cores) from split cores in Hole U1618C. The high-resolution record targeted warm interglacials and their surrounding temporal context, as well as capturing meltwater pulses in the late Quaternary. Determining the intervals for the higher resolution sampling required a highly

integrated, dynamic, and collaborative process. The microbiology team has also been tracking potential sediment contamination from the drilling fluid by using chemical tracers. They have determined empirically that APC sampling leads to less contamination from drill fluid (~15% of samples), while XCB leads to far greater rates of contamination (~57% of samples).

Outreach

The first week on site was spent working on the documentary, becoming familiar with the core flow, and filming detail shots of scientists working. The Outreach Officers (OO) were able to get ample coverage of both the Core Laboratory and drill floor, and they were able to test some more technical shots using overhead rigs, the drone, and situational sound. For social media outreach the OOs released another episode of “The Adventures of the *JOIDES Resolution*,” created a custom animation for International Show your Stripes Day (21 June), and started showcasing the science party through small interview posts. An article for *The Drilling Dispatch, Happening Now* has been drafted and will be reviewed within the week, and an article has been submitted to the editor of *Oceanographic*. An in-depth story for *MOLD Magazine* on the catering staff has been drafted and a portion of the video piece to accompany it has been shot, the goal being to capture an audience unfamiliar with both this research and the *JOIDES Resolution* through the interest in food. Across all social media platforms, we had 40,600 impressions. Two educational tours were conducted, one with the University of Peradeniya, Sri Lanka, and one with Kiel University, Germany.

Technical Support and HSE Activities

Laboratory Activities

- Staff processed cores and samples from Holes U1618A through U1618C.
- sedaDNA samples were taken on the catwalk in Hole U1618B. A team of two technicians helped to cut selected section(s) with cleaned tools, and the Chemistry Laboratory technicians assisted scientists with sampling.
- sedaDNA samples were also taken from split cores in Hole U1618C. Two technicians helped split cores in the splitting room while both scientists took the samples. All air vents were closed during sampling.

Application Support Activities

- Worked on the Hyperscan project.
- Assisted the Stratigraphic Correlator with minor problems.
- Temporarily modified the Coulometer software so that it writes a CSV file with all the points gathered during a measurement.

IT Support Activities

- Completed routine printer and computer maintenance support tasks.
- Preparing for software updates to patch vulnerabilities.
- The ship's business network has been experiencing network outages ranging from 5–30 min at random times.
 - Starlink network has been working well so far.

HSE Activities

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 16 June.