IODP Expedition 403: Eastern Fram Strait Paleo-Archive

Week 4 Report (23–29 June 2024)

Operations

Coring continued in Hole U1618C from 392.1 meters below seafloor (mbsf) to a final depth of 413.1 mbsf at Core U1618C-62X. The C_1/C_2 ratios in headspace gas samples fell quickly in Cores U1618C-61X and 62X, and we decided to terminate coring at the site for safety. The crew began recovering the drill string, with the bit clearing the seafloor at 0801 h (UTC + 2 h) on 23 June 2024. When the bit was clear of the seafloor, the beacon was released and retrieved while the rig crew continued to pull out of the hole. The beacon was recovered at 0945 h and the bit cleared the rig floor at 1120 h on 23 June. The rig floor was secured for transit, the vessel was switched from dynamic positioning (DP) to cruise mode, and the thrusters were up and secure at 1151 h on 23 June, ending Hole U1618C and Site U1618. A total of 61 cores were taken over a 413.1 m interval with one drilled interval of 2.0 m. The advanced piston corer (APC) was deployed for 15 cores over 109.5 m with 110.71 m of recovery (101%). The half-length advanced piston corer (HLAPC) was used for three cores over a 14.1 m interval, recovering 13.71 m of sediment (97%), and the extended core barrel (XCB) corer was deployed for 43 cores over 287.5 m, recovering 326.17 m of sediment (114%). Advances of 7.0 to 7.5 m were used on the majority of the XCB cores to allow for gas expansion. A total of 75.75 h (3.2 d) were spent on Hole U1618C.

The vessel made the 36.3 nmi transit to Site U1619 (proposed Site VRW-03A) in 3.2 h with an average speed of 11.3 kt. The thrusters were down and secure and the vessel switched from cruise mode to DP mode at 1545 h on 23 June, starting Site U1619. A beacon was deployed and a depth reading with the precision depth recorder (PDR) was taken on arrival. The APC/XCB bottom-hole assembly (BHA) was made up and deployed. Hole U1619A was spudded at 2210 h on 23 June. The seafloor was estimated to be 1676.1 meters below sea level (mbsl), based on recovery from Core U1619A-1H. Coring continued with the APC to Core U1619A-11H. Partial strokes were recorded on Cores 10H and 11H, and the hole reached APC refusal. The HLAPC was deployed to advance the hole to a depth of 150.1 mbsf (Cores 12F–22F). Partial strokes were recorded for Cores 21F and 22F. The XCB was deployed to advance the hole from 150.1 mbsf to the total depth of 627.9 mbsf on 28 June (Cores 23X–85X). Because expanding cores had been an issue using the APC and HLAPC tools, advances using the XCB were kept to approximately 7.0 m to allow room in the liner for the core to expand. On the morning of 28 June, the Ice Navigators aboard notified the bridge that the Marginal Ice Zone (MIZ) had moved to within 3 nmi of the vessel. It was decided to deploy a free-fall funnel (FFF) in case the vessel was forced off the site. While deploying the FFF, ice moved into the red zone of our safety perimeter, from both the northwest and southwest. It was decided to terminate coring and end operations until the site cleared. The drill string was pulled to surface, clearing the seafloor at 1505 h on

28 June. The beacon was released after clearing the seafloor and it was recovered at 1600 h. The bit cleared the rig floor at 1940 h and the rig floor was secured for transit. The vessel was switched from DP to cruise mode at 1955 h on 28 June, ending Hole U1619A. A total of 85 cores were taken over a 627.9 m interval. The APC was deployed for 11 cores over 98.4 m with 102.33 m of recovery (104%). The HLAPC was used for 11 cores over a 51.7 m interval, recovering 54.13 m of sediment (105%), and the XCB was deployed for 63 cores over 477.8 m, recovering 571.89 m of sediment (120%). Advanced piston corer temperature (APCT-3) measurements were taken during Cores U1619A-4H, 7H, 10H, and 13F. Sediment Temperature 2 (SET2) formation measurements were taken following Core U1619A-28X at 197.0 mbsf and 44X at 317.0 mbsf. A total of 124.50 h (5.2 d) were spent on Hole U1619A.

The vessel made the 62.8 nmi transit to Site U1620 (proposed Site SVR-03A) in 6.2 h at an average speed of 10.1 kt. The thrusters were down and secure, and the vessel switched from cruise mode to DP mode at 0256 h on 29 June, starting Site U1620 and Hole U1620A. A depth reading with the PDR was taken as the vessel arrived, indicating that the seafloor was 1574.4 mbsl. The crew assembled and deployed the APC/XCB BHA. Hole U1620A was spudded at 0820 h (UTC + 2 h) on 29 June. The seafloor was estimated to be 1577.1 mbsl, based on recovery from Core U1620A-1H. Coring continued with the APC to a depth of 112.6 mbsf (Cores 1H–14H). Partial strokes were recorded on Cores U1620A-3H, 8H, 11H, 12H, and 14H. Following Core U1620A-14H, the XCB system was deployed with 4.8 to 5.5 m advances to allow the cores room to expand without putting pressure on the liners. The headspace gas C_1/C_2 ratio was monitored closely while coring. Measurements of the C_1/C_2 ratio were in the anomalous zone, but additional void space gas analyses indicated that the gas content was all biogenic, so it was deemed safe to proceed. As of 0000 h on 30 June, Hole U1620A had been advanced to a depth of 133.9 mbsf through Core 16X. A total of 16 cores were taken over a 133.9 m interval with 143.66 m of recovery (107%). The APC was deployed for 14 cores over 123.6 m, recovering 128.42 m (104%). The XCB was used over a 10.3 m interval, recovering 15.24 m (148%). APCT-3 temperature measurements were taken on Cores U1620A-4H, 7H, 10H, and 13H. Nonmagnetic core barrels were used on all APC cores.

Science Results

Lithostratigraphy

The sedimentology team described Cores U1618C-56X to 62X, U1619A-1H to 85X, and U1620A-1H to 15X. The primary lithologies encountered in Holes U1618C, U1619A, and U1620A are dark gray silty clays and clayey silts with few alternating coarser silty layers, as well as sandy clay, sandy silt, and sandy mud. Dispersed to abundant clasts, interpreted as ice-rafted debris (IRD), are present in some cores with grain sizes ranging from coarse sand to

gravel. Bioturbation, ranging from slight to high, is seen in several sections in Holes U1618C and U1619A.

Biostratigraphy

An age-depth model has been developed for Site U1618, and it indicates that this site probably reaches the late Pliocene. Core catcher (CC) samples and selected intervals have been analyzed for nannofossils, diatoms, planktic foraminifers, and dinocysts at Hole U1619A. Preliminary data show that Hole U1619A covers the Pleistocene and Pliocene, but it is not yet determined whether the lowermost part of the site is Miocene. At Site U1620, preparation and analysis of CC samples and selected levels are in progress.

Paleomagnetism

Paleomagnetic and rock magnetic investigations of discrete cube samples and archive half sections were completed for Hole U1619A and continued for Hole U1620A. Greigite minerals are found in several layers, but to a much lesser extent than at Site U1618. Alternating field (AF) paleomagnetism data are good at Site U1619, and the paleomagnetism group identified several major magnetic reversals. The bottom of Hole U1619A may be early Miocene based on magnetic stratigraphy. In addition, the group analyzed the upper 12 cores of Hole U1620A. Again, major paleomagnetic boundaries are identified and the group is currently homing in on the location of the Gauss Chron (<2.57 Ma).

Geochemistry

The geochemistry group continued to monitor headspace gas at Hole U1619A. C_1/C_2 ratios decreased with depth, staying within the normal range of 152 or more, consistent with biogenic derived gas. As a result, we could safely continue drilling deeper than at Site U1618. Interstitial water (IW) samples from Hole U1619A show lower alkalinity and higher salinity at this site compared to Site U1618, which is consistent with the elevated influence of gas hydrates at Site U1618. The final IW sample was taken from Section U1619A-62X-4. At this depth, sediments were too compacted to yield sufficient pore water for analysis. At Site U1620, the group is actively monitoring the headspace gas measurements, as the Svyatogor Ridge is a known and active gas hydrate system. C_1/C_2 levels are relatively low, and higher molecular weight hydrocarbons are detectable above trace amounts, from ~141 mbsf. As the appearance of the higher molecular weight hydrocarbons is not showing a consistent increase with depth, they may be permeating the sediment profile horizontally from a chimney nearby, not necessarily from a hydrocarbon reservoir directly below our hole. IW measurements from Hole U1620A are in progress. Alkalinity shows a peak at Core U1620A-3H, while salinity decreases slowly and consistently downhole from near seawater values (34 ppt) to 32 ppt in Core 17X.

Physical Properties

The physical properties team continued collecting high-resolution data for gamma ray attenuation (GRA) bulk density, magnetic susceptibility (MS), *P*-wave velocity, and natural gamma radiation (NGR), as well as low-resolution thermal conductivity and moisture and density (MAD) data for Holes U1619A and U1620A. Additionally, anelastic strain recovery (ASR) instruments continued collecting logarithmical recovery of anelastic strain for whole-round samples from Holes U1618B, U1618C, and U1619A. Hole U1619A GRA values increase downhole with an increasing degree of compaction, and the MAD-derived bulk density values follow the same trend. In contrast to Site U1618, the upper 30 cores of Hole U1619A display MS values that appear to have a closer association with the described lithofacies, and thus might indicate a lower overprint by the presence of greigite. However, the lower part of Hole U1619A contains MS values that are interspersed with outsized peaks, indicative of postdepositional alteration from greigite. In both Holes U1619A and U1620A, NGR continues to be a valuable tool for tracking lithofacies variability.

In collaboration with the Lamont-Doherty Earth Observatory (LDEO) on shore, the Downhole Measurements Scientist is interpreting the processed downhole data from Hole U1618B. Downhole logs of physical properties indicate good correlation with the measurements conducted on cores by the track systems in the laboratories. In particular, the reprocessing of downhole *P*-wave signals, measured with the Formation MicroScanner (FMS)-sonic tool string, yielded important results as most of the *P*-wave measurements using the Whole-Round Multisensor Logger (WRMSL) and gantry systems in the shipboard laboratories failed due to the presence of gas and/or larger clasts. In Holes U1619A and U1620A, downhole temperature was measured using the APCT-3 during APC and HLAPC coring and the SET2 probe when XCB coring (Operations Summary). Site U1620 has a much higher geothermal gradient than Sites U1618 and U1619 and is in good agreement with our expectation, as this site is closer to the Molloy Transform Fault and overlies younger oceanic crust.

Stratigraphic Correlation

The Stratigraphic Correlators established a stratigraphic splice for Site U1618 and produced the final splice and affine tables for the science party. Correlation was not conducted at Site U1619, as we only cored one hole. Because of a strong expansion of the XCB cores at Hole U1619A, each core was appended by the amount of overlap with the preceding core, to generate an ad-hoc affine table with a core composite depth below seafloor (CCSF) scale. The recovery at Site U1619 was notably better than at Site U1618, and in the event we cannot return to Site U1619, the record will have good stratigraphic coverage despite the gaps. Currently the same procedure is done for Hole U1620A, where the gas-driven expansion of the sediment started early within the APC cores.

Microbiology

Six sedimentary ancient DNA (sedaDNA) samples were taken from split core surfaces from Core U1619A-56X to test the preservation potential for ancient DNA at this site. Controls of chemical tracers in the drill fluid suggest that at least some of our samples do not have drill fluid contamination. A mudline sample for sedaDNA was collected at Hole U1620A. Low resolution catwalk sampling is planned for Hole U1620B.

Outreach

This week the Outreach Officers (OO) and one of the scientists led a tour with a high school in Sri Lanka, with most of the tour being given in Tamil. The OOs were able to get coverage on the inner workings of the ship with the Chief Engineer, and some amazing views of a reentry cone being dropped through the moonpool at Hole U1619A. This week the group pivots to shadowing scientists to try to get coverage of the process and audio of each step of the onboard core analyses. Across all social media platforms, we had 18,500 impressions. A reason for the decline might be the longer form videos published.

Technical Support and HSE Activities

Laboratory Activities

- Staff processed cores and samples from Holes U1619A and U1620A.
- Staff continue to handle the gassy cores, expansion, and shattered liners.
    - Kevlar blankets are used both on the drill floor and catwalk.
- Staff brought up Cores U1619A-1H through 31X from the reefer for the sedimentologists to X-ray scan, as there may not be an opportunity to return to the site due to ice conditions.

Application Support Activities

- Supported the Stratigraphic Correlators' exporting data.
- Added a true/false display option to the CorePhoto report in LORE. This can help the Publications Specialist download only the CorePhoto images with the "true" flag.
- Working on the Correlator Downloader software, changing the format of the Section Summary Report.
- Continued to work on the Hyperscan project.

IT Support Activities

- Routine server, printer, and computer support tasks were completed.
- Arrival of outside emails to the *JOIDES Resolution* stopped due to the exchange server being out of space. We contacted the TAMU exchange group and they helped us add more space, as well as update the server.

HSE Activities

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 24 June.