IODP Expedition 403: Eastern Fram Strait Paleo-Archive

Week 5 Report (30 June–6 July 2024)

Operations

Extended core barrel (XCB) coring continued with Cores U1620A-17X to 31X from 133.9 to 239.9 mbsf. The cores were advanced between 6.0 and 8.0 m to allow for gas expansion. Due to a low C_1/C_2 ratio that plotted outside of our safety envelope, coring was terminated after Core U1620A-31X. The bit was pulled out of the hole, clearing the seafloor at 2025 h on 30 June 2024, ending Hole U1620A. A total of 31 cores were taken over a 239.9 m interval with 277.10 m of recovery (116%). The advanced piston corer (APC) was used for 14 cores over 123.6 m, recovering 128.42 m (104%). The XCB was used over a 116.3 m interval, recovering 148.68 m (128%). Formation temperature measurements using the advanced piston corer temperature (APCT-3) tool were taken on Cores U1620A-4H, 7H, 10H, and 13H. The Sediment Temperature 2 (SET2) tool was deployed following Cores U1620A-18X and 31X. Nonmagnetic core barrels were used on all APC cores.

The vessel was offset 200 m at a bearing of 63.9°, arriving over the hole coordinates at 2050 h on 30 June. A precision depth recorder (PDR) reading was taken during the move, and it was decided to set the bit at 1582.5 meters below sea level (mbsl) for the spud attempt. An APC core barrel was deployed and fired but did not retrieve any sediment. The bit was lowered to 1588.5 mbsl and another barrel was deployed. Hole U1621B was spudded at 2327 h on 30 June. Seafloor was calculated to be 1597.1 mbsl based on the 0.34 m recovered in Core U1620B-1H. It was decided to terminate coring in Hole U1620B to obtain a better mudline core, and the hole ended at 0000 h on 1 July. A total of one core was taken over a 0.4 m interval with 0.34 m of recovery (85%).

The vessel remained in the same location and the bit was lowered to a depth of 1595.3 mbsl. An APC core barrel was deployed and Hole U1620C was spudded at 0033 h on 1 July. Seafloor was calculated to be 1597.1 mbsl based on recovery from Core U1620C-1H. Coring continued using the APC to a depth of 109.4 meters below seafloor (mbsf). The XCB was then deployed, and coring continued to a depth of 169.9 mbsf. With the C_1/C_2 ratio continuing to drop, it was decided to terminate coring in Hole U1620C. The bit was pulled out of the hole, clearing the seafloor at 2345 h on 1 July, ending Hole U1620C. A total of 21 cores were taken over a 169.9 m interval, recovering 186.89 m of sediment (110%). The APC was deployed for 13 cores over a 109.4 m interval with 116.35 m of recovery (106%), and the XCB was deployed for eight cores over a 60.5 m interval, recovering 70.54 m of sediment (117%). The APCT-3 was deployed on Cores U1620C-4H, 7H, 10H, and 13H. Nonmagnetic core barrels were used on all APC cores.

The vessel was offset approximately 100 m at 244° and Hole U1620D was spudded at 0214 h on 2 July. Seafloor depth was calculated to be 1586 mbsl. Coring continued with the APC to a depth of 91.5 mbsf (Core U1620D-10H). The XCB was then deployed for Cores 11X–73X, to a total depth of 616 mbsf. The C_1/C_2 ratio was monitored throughout coring and improved with depth. Upon completion of coring, Hole U1620D was prepared for downhole wireline logging and the bit was pulled up to 71.5 mbsf. The Schlumberger logging line was rigged up and the triple combination (triple combo) tool string was assembled and deployed at 0700 h on 6 July. The tool string encountered an obstruction at 579.5 mbsf and the main uplog began from that point. The tools were recovered and rigged down at 1415 h on 6 July. During logging, 10 sections of the hole between 127.5 and 347.5 mbsf were noted to be 2–3 inch undergage, indicating that the hole closed in at a speed of about 1 inch/h. Due to poor hole stability, the second planned logging run with the Formation MicroScanner (FMS)-sonic tool was cancelled and operations were terminated. The bit was pulled out of the hole, clearing the seafloor at 1423 h and the rig floor at 1800 h on 6 July. The rig floor was secured for transit and the vessel switched to cruise mode at 1909 h on 6 July, ending Hole U1620D. A total of 73 cores were taken over a 616 m interval, recovering 667.91 m of sediment (109%). The APC was deployed for 10 cores over a 91.5 m interval with 99.1 m of recovery (108%) and the XCB was deployed for 63 cores over a 524.5 m interval, recovering 568.81 m of sediment (108%). Nonmagnetic core barrels were used on all APC cores. Short advances of 7.0 to 8.0 m were used for Cores U1620D-11X to 53X to allow for core expansion due to gas. Full advances were used on Cores U1620D-64X to 73X.

All thrusters were up and secure at 1920 h, and the vessel began its sea passage to Site U1621 (proposed Site BED-01A) at 1930 h on 6 July. The vessel had completed 53.0 nmi of the 138 nmi transit at an average speed of 11.8 kt by 0000 h on 7 July.

Science Results

Lithostratigraphy

The sedimentology team described all cores from Holes U1620A, U1620B, and U1620C, and Cores U1620D-1H to 65X. The primary lithologies encountered at Site U1620 are predominantly silty clays and clayey silts with few layers of sandy mud, many light brown layers rich in detrital carbonate, and thin laminations ranging in color from light brown to gray to black. Clasts larger than 3 cm are present in some cores, with grain sizes ranging from coarse sand to gravel/pebbles.

Biostratigraphy

Site U1620 was analyzed for calcareous nannofossils, dinocysts, diatoms, and planktic foraminifers. Diatoms are only occasionally recorded and planktic foraminifers are only consistently present in the upper ~40 m of Hole U1620A. Calcareous nannofossils appear intermittently and dinocysts are present throughout, with a few exceptions. Calcareous

nannofossils and dinocysts in Hole U1620A record several biostratigraphic events in the Pleistocene. Planktic foraminifers, calcareous nannofossils, and dinocysts converge on a Late Pliocene age for the lower part of Hole U1620D. Overall, biostratigraphic data show that Site U1620 recovered sediment from Late Pliocene to Pleistocene.

Paleomagnetism

Paleomagnetic measurements of archive half sections and paleomagnetic and rock magnetic measurements of discrete cube samples from the working halves were completed for Site U1620. Polarity determinations were complicated by recovery challenges with XCB coring and likely by some remagnetization by greigite at depth. Intervals with high magnetic susceptibility (MS) peaks are common below depths of around 140 mbsf and are often associated with small iron sulfide nodules visible on the split core surface, like those observed at similar depths at Sites U1618 and U1619. Interpreting the paleomagnetic data in the context of MS and anhysteretic remanent magnetization (ARM) coercivity indicates that we recovered sediments deposited from 0 to ~2 Ma in the upper 120 m. Below that, between ~120 and 610 mbsf, we recovered an interval with higher accumulation rates with measurements indicating that the site reached the Late Pliocene. Polarity boundaries can likely be refined in postcruise analyses with careful assessment of the magnetic mineralogy.

Geochemistry

This week, the geochemistry group measured interstitial water (IW), headspace gas, and sediment samples from Holes U1620C and U1620D. In particular, the group compared the data from these measurements to investigate the origin of the hydrocarbons and presence of gas hydrates. The comparison focused on hydrocarbon gas concentration, alkalinity, iron, and magnesium content. Hydrocarbon concentrations were generally high and showed unique trends in this location, possibly linked to the proximity to the ultraslow spreading mid-ocean ridge. An interval of increased high molecular weight hydrocarbons (C_2–C_6) was identified between ~150 and ~250 mbsf in Holes U1620A, U1620C, and U1620D. In addition, the IW data also suggest an increase in sulfate, along with Mg and Fe. Interestingly, methane shows peaks at both the top and bottom of Hole U1620D. The methane at the top of the core is likely biogenic as it increases once sulfate is no longer in the system, consistent with microbial methanogenesis. The methane at the bottom of the core may be sourced from deeper abiotic crustal processes, e.g., serpentinization, related to the ultraslow spreading mid-ocean ridge at this location. Carbonate analysis revealed generally increasing total organic carbon downcore. Total nitrogen mirrors this trend, suggesting marine productivity exerts a primary control on sediment organic carbon at this site. Lastly, a substantial increase in calcium carbonate was observed below ~350 mbsf.

Physical Properties

The physical properties team scanned whole-round cores for gamma ray attenuation (GRA) bulk density, MS, *P*-wave velocity, and natural gamma radiation (NGR). MS values continue to be influenced by authigenic processes at depths below ~150 mbsf. NGR and GRA show a positive linear correlation, with possible associations between NGR, GRA, and lithofacies. Both NGR and GRA show a general increase in values downcore indicating a greater degree of compaction. Density derived from discrete samples follows the GRA trends. Thermal conductivity similarly increases with depth. Anelastic strain recovery instruments continue to collect logarithmical recovery of anelastic strain for whole-round samples collected at Site U1620 and from previous sites.

In situ formation temperature measurements were conducted with the APCT-3 and SET2 tools in Holes U1620A, U1620C, and U1620D. The data indicate a much higher geothermal gradient than that of comparable oceanic sediments. At Hole U1620D, the triple combo was deployed for downhole logging. Borehole diameter, NGR, density, porosity, and electrical resistivity were amongst the measured parameters. During the run, the Accelerator Porosity Sonde (APS) showed a significant drop in internal voltage. Upon recovery, it was detected that the APS suffered from an electric arc that rendered the tool defunct for the rest of the expedition. At the end of the week, all data were sent to the Lamont-Doherty Earth Observatory for postprocessing. Processed data are expected to arrive later next week.

Stratigraphic Correlation

For Site U1620, stratigraphic correlation constructed two spliced intervals, one from 0 to 191.135 m core composite depth below seafloor (CCSF) based on correlations among three holes (U1620A, U1620C, and U1620D), and one from 191.135 to 271.233 m CCSF based on a correlation between Holes U1620A and U1620D. Only Hole U1620D extends below 271.233 m CCSF, and cores from Hole U1620D were appended according to their individual expansion.

Microbiology

The microbiologists sampled at a low resolution of one sample plus one contamination tracer sample per core in Hole U1620C and at high resolution in Hole U1620D that targeted marine isotope stage (MIS) 5e, MIS 11, and MIS 31. For high resolution analyses, Sections U1620D-2H-3 to 7, U1620D-3H-1 to 7, U1620D-4H-1 to 5, U1620D-6H-2 to 9, and U1620D-7H-2 to 8 were sampled at a resolution of three sample horizons per section. Each horizon consists of two DNA samples plus one sample for contamination tracer testing. In addition, two whole-round samples were taken from ~300 and ~400 mbsf from Hole U1620D. Tracer analysis is ongoing, and preliminary assessment of the data suggests low rates of tracer contamination at this site.

Education and Outreach

The onboard Outreach Officers (OOs) wrapped up draft and media materials for MOLD Magazine and the food feature. Oceanographic magazine responded saying the article should be live in the next two weeks, but scheduling is slowing it down at the moment. For the documentary the OOs were able to shoot footage in the laboratory, shadowing most of the biostratigraphy and paleomagnetism working groups, as well as getting some good footage on the rig floor. The group released their second face filter with a third to be released in the next few days. While the articles are in the editors' hands, the OOs are currently reaching out to artists who can publish things in real time that may be able to grow the social media audience. Across all social media platforms, we had 19,200 impressions.

Together with two Chinese scientists, the OOs led one ship-to-shore tour for the Yangpu Library, China.

Technical Support and HSE Activities

Laboratory Activities

- Staff continued to handle cores with high gas content that resulted in expansion and shattered liners.
    - Kevlar blankets were used both on the drill floor and catwalk for Site U1620 cores.
- One of the Carver presses was having an issue holding pressure and was rebuilt by the Electronics Technician. It continues to have some issues but it is currently working.

Application Support Activities

- Helped the technicial staff and scientists with minor software issues.
- Worked on the Hyperscan project.
- Worked on Asset Management System (AMS) software.

IT Support Activities

- Routine server, printer, and computer support tasks completed.
- Replaced Zebra label printer in the core entry space with new spare Zebra ZT411 53958. We repaired the printer and set it back as a spare.

HSE

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 30 June.