IODP Expedition 379: Amundsen Sea West Antarctic Ice Sheet History

Week 8 Report (3–9 March 2019)

This week, we reentered Hole U1533B, and RCB Cores 32R to 43R penetrated from 283.9 to 382.6 m and recovered 14.7 m (15%). Of the 4.60 d of drilling operations this week, drifting ice caused multiple interruptions to coring operations that totaled 1.93 d. At 0315 h on 7 March, we had to stop further operations to return to Chilean waters to evacuate an injured crew member. We spent the remainder of the week in transit.

Operations

This week began with us continuing to retrieve the drill string after pulling out of Hole U1533B. The advanced piston corer/extended core barrel (APC/XCB) bit arrived back on the rig floor at 0820 h on 3 March. Core 31X was recovered with the drill string. We prepared the rotary core barrel (RCB) bottom-hole assembly and lowered it the seafloor. We deployed the camera system to prepare for reentering Hole U1533B. During this deployment of the camera system, we attached the APC temperature tool (APCT-3) to the camera system to measure the seawater temperature from the surface to just above the seafloor. Once the camera system reached the bit, we adjusted the bit depth to reenter Hole U1533B, but approaching ice forced us to raise the bit back up to 70 m above the seafloor at 2045 h on 3 March. We were cleared to resume operations at 2215 h and we reentered Hole U1533B at 2305 h on 3 March. We recovered the camera system and lowered the bit into Hole U1533B. After the camera system was back aboard, we installed the top drive and circulated and rotated back to the bottom of the hole (283.9 m). We could not start coring due to approaching ice, and we waited from 0315 to 0630 h on 4 March. Unfortunately, the ice kept converging on our location, so we had to raise the bit back up to 66 m below the seafloor. At 1215 h on 4 March, we resumed operations and lowered the bit back toward the bottom of the hole. The bit encountered resistance at 257.6 m and we had to drill back down to the bottom of the hole. At 1345 h on 4 March, we started RCB coring from 283.9 m. Cores U1533B-32R to 35R then penetrated to 316.0 m but recovered only 0.07 m (0.2%). At 2245 h on 4 March, we raised the bit back up to 65.5 m below the seafloor due to approaching ice.

After ice cleared the area at 0145 h on 5 March, we lowered the bit from 65.6 m back down the hole. The bit encountered fill at 267.6 m, so we installed the top drive and circulated/rotated the rest of the way. We resumed RCB coring from 316.0 m at 0415 h on 5 March. Cores U1533B-36R to 38R then penetrated to 341.7 m before we had to stop coring again at 1130 h due to approaching ice. We raised the bit back up to 65.5 m, reinstalled the top drive, and recovered Core 38R at 1415 h on 5 March. At 1845 h, we were able to resume operations, so we lowered the bit back down the hole, installed the top drive when the bit was at 324.6 m, and

circulated/rotated back to the bottom of the hole (341.7 m). Cores 39R to 40R penetrated to 360.9 m. Before we could recover Core 40R, however, approaching ice forced us to pause operations again at 2315 h on 5 March. We waited for the ice with the bit near the bottom of the hole. We did not install the core line to retrieve Core 40R as this would increase the time required to pull out of the hole if the ice kept approaching. At 0315 h on 6 March, we were finally able to recover Core 40R and resume coring. Cores 41R to 43R penetrated from 360.9 to 382.6 m. At 0930 h on 6 March, approaching ice again forced us to raise the bit back up to 65.6 m below the seafloor. The ice kept approaching and we had to pull the bit completely out of Hole U1533B at 1115 h. With the bit 106 m above the seafloor, we installed the top drive, installed the core line, and recovered Core 43R at 1300 h. We then deployed the camera system at 1330 h on 6 March so we would be ready to reenter Hole U1533B as soon as the ice would allow. While waiting for the ice to move away, we conducted a camera survey of the seafloor from 1845–2030 h on 6 March.

We continued to wait for ice to clear the area with the bit 50 m above the seafloor until 0100 h on 7 March. We then reentered Hole U1533B at 0155 h, started to retrieve the camera system, and began lowering the bit into the hole. When the bit had reached 324.6 m at 0315 h on 7 March, we had to stop any further operations to return to Chilean waters to evacuate an injured crew member. Overall in Hole U1533B, we drilled without coring from the seafloor to 25.5 m, installed a reentry system with casing to 24.35 m, and cored 357.1 m (25.5–382.6 m) with a recovery of 250.78 m (70%).

After the camera system was back aboard at 0430 h on 7 March, we recovered the drill string, and the rig floor was secured for transit at 1330 h. We raised the thrusters and began the transit at 1448 h on 7 March. Poor visibility combined with ice in the area initially limited our speed to ~6 to 7 nmi/h though the morning of 8 March; thereafter, improved visibility allowed us to increase speed to 12.8 nmi/h. As of 2400 h on 9 March, we have completed 582 nmi of the planned 1358 nmi transit to Chilean waters to reach the meeting point for the medical evacuation.

Science Results

This week scientists completed most remaining Hole U1533B analyses, met to present data collected this week and overall Site U1533 results, completed revisions to Methods reports created earlier in the expedition, and participated in group meetings to discuss postcruise research.

Lithostratigraphy

Cores U1533B-24X to 43R were collected, completing Site U1533. Cores 32R, 34R, 36R, 38R, and 40R had no recovery. The remaining cores were X-rayed, split, and sampled, and the archive half was described. Cores 33R and 35R contained only fall-in pebbles of igneous and

metamorphic lithologies without matrix. Cores 31X and 37R had less than 12% recovery, mainly consisting of highly disturbed sediments. Handheld X-ray fluorescence (XRF) measurements were made on all interstitial water squeeze-cake residues for Hole U1533B cores.

The primary lithology in Cores U1533B-24X to 43R is dark greenish gray barren to diatom-bearing thinly laminated silty clay, interlaminated with gray silt. Greenish gray bioturbated muddy diatom-rich mud to diatom ooze was observed in Cores 26X, 28X, 39R, 42R, and 43R. Mud with dispersed to common clasts occurs in Cores 28X and 42R. A massive dark gray sandy diamictite and a muddy conglomerate were observed in Core 26X. Carbonate-fluorapatite cement occurs as a 3 cm thick bed in Core 39R, along with semilithified, up to 4 cm thick, intervals recording the early stages of opal diagenesis in Cores 39R and 42R. Core disturbance ranged from slight to high, primarily due to biscuiting related to drilling.

Biostratigraphy

Over the past week the Micropaleontology group concentrated on biostratigraphic analysis of the lower interval of Hole U1533B (Cores U1533B-24X to 43R; ~209 to 381 m), conducting limited additional sampling to refine age control and preparing an integrated age-depth model for the entire sequence recovered at the site.

Apart from a barren interval between Cores U1533B-28X and 31X (~257–282 m), siliceous microfossils are rare to abundant and indicate a latest Miocene to earliest Pliocene age for the lower section of Hole U1533B. Radiolarian assemblages constrain the age of the interval between ~172 and 347 m at 4.59 to 6.22 Ma (Tau Zone), and the interval between ~362 and 376 m is assigned an age between 6.22 and 6.84 Ma (*A. challengerae* Zone). The age of the bottom of Hole U1533B (~381 m) is constrained to approximately <6.4 Ma based on the presence of the diatom *Thalassiosira miocenica* at ~377 m.

All the core catcher samples examined this week from Cores U1533B-24X to 43R (~209 to 381 m) are barren of foraminifers. Marine and terrestrial palynomorphs are present in most samples examined. A rare in situ dinocyst assemblage of low diversity was encountered in Samples U1533B-24X-CC to 43R-CC but does not provide biostratigraphic age constraints. Rare to common reworked terrestrial palynomorph assemblages are present in most samples.

Time was also spent on writing reports as well as chronostratigraphic correlation in collaboration with the Paleomagnetic, Petrophysics, and Lithostratigraphic teams.

Paleomagnetism

After measuring the natural remanent magnetization (NRM), all archive-half sections of Cores U1533B-23X to 43R were continuously demagnetized using alternating field (AF) demagnetization up to 20 mT in increments of 5 mT at 2.5 cm intervals. NRM intensity ranges from very low values of ~10^{-4} to high values of ~10^{-1} A/m. We also collected 17 oriented discrete samples from working-half sections and measured them for bulk and anisotropy of

magnetic susceptibility. The results demonstrate a prominent anisotropy down to Section U1533B-39R-1, with the maximum susceptibility axis within the bedding plane. To the bottom of Hole U1533B (Sections U1533B-39R-2 to 43R-1) anisotropy decreases significantly, although the maximum susceptibility axis is still within the bedding plane. Demagnetization of NRM at the 20 mT level reveals a bottom age for Hole U1533B between the termination of subchron C3An.1n (6.033 Ma) and the beginning of subchron C3An.2n (6.733 Ma). Oscillating values of normal and reversed polarity at the bottom of Hole U1533B show no clear indication that subchron C3Ar was recovered. Results from archive-half sections were confirmed by AF demagnetization of the discrete samples.

Petrophysics

Density and magnetic susceptibility were measured using the Whole-Round Multisensor Logger (WRMSL) with a measurement interval of 2.0 cm. *P*-wave velocity of whole-round cores was not measured for XCB and RCB cores due to incomplete filling of the core liner. Natural gamma radiation was also measured on whole-round cores at an interval of 10 cm. Additionally, eight thermal conductivity measurements were conducted on split-core sections. Moisture and density (MAD) measurements were made on 28 discrete samples, and 39 *P*-wave caliper velocity measurements were made on split-core sections. Data sets were cleaned and finalized at the completion of Site U1533, and a shipboard collaborative splice was created with initial constraints by physical properties data.

Geochemistry

Sampling and analyses for interstitial water (IW) and bulk organic geochemical properties of sediments were continued at Hole U1533B. A total of six IW samples were collected from Hole U1533B down to 374.8 m. The extracted water volume ranged from 4 to 20 ml (average = ~12 ml), allowing us to measure salinity, alkalinity, pH, chlorinity, and nutrients. In addition, major cation and anion analyses in all IWs from Holes U1533A and U1533B were completed. K and Mg concentrations show a decreasing trend with depth, whereas Ca, Li, and Sr concentrations show a linear increase. $H_4Si(OH)_4$ concentrations usually have values higher than 300 μM, which is probably related to diatom dissolution at Site U1533.

Headspace gas analysis for safety monitoring detected only low methane concentrations (~4 ppmv) in all samples down to 306.4 m. Below this depth, methane concentrations increased rapidly and showed maximum values of ~6400 ppmv at 375.02 m. Thereafter, methane concentrations declined to 1755 ppmv at the base of Hole U1533B. Collection of two discrete samples per core for the analyses of total carbon, total organic carbon, total nitrogen, total sulphur, and carbonate continued for Hole U1533B. Total carbon content stayed low and was mainly controlled by facies-related variations in the abundance of organic matter. Only low calcium carbonate concentrations were observed at Hole U1533B with little downcore variation.

Outreach

The Outreach Officers continued to document the expedition with photos, videos, writing, and comics. Work continued on comics involving roughnecks working on the drill floor, granite samples being used to unravel the history of Marie Byrd Land/West Antarctic Ice Sheet, and work in the Core Laboratory. A comic about one of the Co-Chief Scientist's work was posted on social media. A photo-illustrated story about the Geochemistry Laboratory was produced, translated to Korean, and posted. A scientist from Japan shared the Japanese comic translation on the J-DESC site. Media interviews and university group broadcasts are scheduled for the final week of the trip. Interviews for postcruise videos and articles continue to be conducted with shipboard scientists. Blog posts have been posted on the *JOIDES Resolution* website (http://joidesresolution.org) and sent to the British Antarctic Survey for posting. A short film has been commissioned by BBC Global News about the expedition and filming is underway. BBC Earth shared photos and a summary of the expedition on their Instagram account, which achieved 37,000 likes and reached an audience of over two million people.

Technical Support and HSE Activities

Staff continued supporting Site U1533 science activities, as well as preparing for the transit and end-of-expedition activities.

Logistics

- Work continued for offgoing shipments.
- Completed physical count on specific curation supplies as requested by shore.

Laboratory Activities

- Physical Properties:
    - NGR: Tested voltage bias potentiometers on detector #7 and found no issues. Troubleshooting efforts continue.
- Underway Geophysics:
    - Dismantled and stored vertical seismic profile (VSP) rigging and hardware.
    - Made up new lines for VSP handling.
    - Staff learned how to make eye splices for handling lines.
- X-Ray Imaging:
    - Work continued on documentation.
    - Training staff on track operations and how to take good X-ray images.

Application Support Activities

- X-ray Image Upload: Looking at ways to provide top and bottom offsets that will make sense to the database model.
- pXRF Report: Fixed null display issues.
- Drill Report: Fixed the duplicated detail-report items in report.
- Image Capture: Worked with Imaging Specialist and Marine Computer Specialist to resolve issues associated with processing certain image files.
- Correlation Downloader: Finished migration to Java 11.

IT Support Activities

- Email: JR Exchange email server failed. Worked with TAMU support staff and discovered that the activity log file had accumulated until all available disk space on server was consumed. Cleared log file and implemented log-rotation schema to remediate matter and future prevention.
- Extreme: Continue working with Extreme staff to identify personal computer self-registration issues. Performed another round of configuration changes and testing, collected various log files, and emailed results for analysis.
- VSAT: UPS that powers the VSAT electronics failed; removed from service. New batteries have been ordered.
- Expedition 383: Working with Rignet regarding satellite coverage for expedition.

HSE Activities

- Weekly fire and boat drill was held as scheduled.