

IODP Expedition 383: Dynamics of Pacific Antarctic Circumpolar Current (DYNAPACC)

Week 4 Report (9–16 June 2019)

Week 4 of the International Ocean Discovery Program (IODP) Expedition 383, Dynamics of the Pacific Antarctic Circumpolar Current (DYNAPACC), was spent coring at Site U1540 and transiting to Site U1541. At Site U1540 we cored Holes U1540B (0–150 m below seafloor [mbsf] with a total of 10 m drilled without recovery and 140.8 m recovered [101%]), U1540C (0–6.8 mbsf with 6.8 m recovered [100%]), U1540D (0–211 mbsf with a total of 58.7 m drilled without recovery and 151.0 m recovered [99%]), and U1540E (135–213 mbsf with 2 m drilled without recovery and 78.9 m recovered [100%]). All times in this report are in ship local time (UTC – 3 h).

Operations

This week started as we were preparing to spud Hole U1540B with the bit at 3575 m below rig floor (mbrf). Our first attempt to take Core 1H did not retrieve any sediment. The bit was then lowered 9.5 m to 384.5 mbrf and Hole U1540B was started at 1220 h on 9 June. Based on the Core U1540B-1H recovery, the seafloor was calculated at 3580.0 m below sea level (mbsl). Advanced piston corer (APC) coring continued to 150 mbsf with three drilled intervals (totaling 10 m) to help obtain a good overlap with Hole U1540A cores. A total of 16 cores were taken over a 140.8 m interval with 101% recovery. Misfires were recorded on Cores U1540B-1H, 6H, 8H, and 11H. The bit was pulled back to the seafloor and cleared the seafloor at 0958 h on 10 June 2019, ending Hole U1540B.

After coring Hole U1540B, permission was requested from the IODP Environmental Protection and Safety Panel to extend the penetration depth at Site U1540 from 150 to 275 mbsf. The rationale behind this request was based on the successful recovery of a complete and continuous Pleistocene sedimentary record in Holes U1540A and U1540B. The increase in penetration depth would allow us to extend this record into the Pliocene, expected directly below the already cored maximum depth of 150 mbsf. An additional rationale was based on the prevailing sea conditions on site, which predicted two additional days of reasonably calm seas, thus allowing for further drilling, while significantly worse sea conditions were forecast at our two other primary sites in the South Pacific.

Hole U1540C was spudded 20 m south of Hole U1540B at 1110 h on 10 June with the bit positioned at 3587.5 mbrf. Based on the recovery from Core U1540C-1H, we determined that the mudline was missed and the hole was ended at 1200 h.

The vessel was offset 20 m to the west of Hole U1540C and the bit was spaced out to 3587.5 mbrf to start Hole U1540D. Core U1540D-1H was taken at 1235 h and recovered 8.92 m

(100%). This allowed us to determine a water depth of 3577.5 mbsl. Permission to extend the penetration depth at Site U1540 to 275 mbsf was received while retrieving Core 11H from 79.2 mbsf. Then we drilled ahead without recovery to 131.0 mbsf before resuming coring operations. The full-length APC coring system was deployed and the hole was deepened until we reached APC refusal at 210.5 mbsf. Cores 21H–22H (207.0–210.5 mbsf) recovered just 3.9 m of sediment, with numerous rock fragments. The extended core barrel (XCB) system was deployed for one core in an attempt to recover more of the presumed basement material. After coring for 45 min, the core barrel was pulled up to the surface with only 0.5 m of advancement and no recovery, and the decision was made to terminate the hole. The bit cleared the seafloor at 1710 h on 11 June, ending Hole U1540D. A total of 19 cores were taken over a 151.8 m interval with 151 m recovered (99%). Misfires were recorded on Cores 4H and 6H, and partial strokes were recorded on Cores 22H and 23H.

The vessel was offset another 20 m to the west of Hole U1540D, and the bit was spaced out for spudding using a seafloor depth calculated from Hole U1540D. Hole U1540E was spudded at 1840 h on 11 June and drilled ahead to 135.0 mbsf. The hole was then cored using the full-length APC system, reaching refusal at 213 mbsf. The bit was then recovered to the vessel, clearing the rotary table at 1900 h on 12 June 2019. The rig was secured and readied for transit at 1905 h. A total of eight cores were taken in Hole U1540E with the APC system over a 76.0 m interval with 78.9 m recovered (104%). Core U1540E-10H experienced a partial stroke. There were two drilled intervals that advanced a total of 137.0 m.

With the seas too high to raise the thrusters, the vessel waited on weather until the seas calmed sufficiently at 1545 h on 13 June. The thrusters were then raised and the vessel began the transit to Site U1541 (proposed Site CSP-1A). Weather and high seas resulted in reduced speed during the transit. Upon reaching the Site U1541 coordinates at ~2300 h on 15 June, rough weather and seas precluded operations and the vessel continued on a southwest weather avoidance course.

Science Results

Sedimentology

We processed sediment cores from five holes at Site U1540 during this week. Core description and scanning for color reflectance and X-ray images was finished and results were presented during the site summary meeting. Three major lithostratigraphic units were determined at Site U1540. Unit I is characterized by alternations of diatom ooze, carbonate-bearing or carbonate-rich diatom ooze, and calcareous/nannofossil ooze. This unit is subdivided into two subunits: Subunit IA from the seafloor to ~62.3 m CCSF-A (core composite depth below seafloor) and Subunit IB from ~62.3 to ~177.8 m CCSF-A. Subunit IB has an increased dominance of nannofossil ooze and less variability in sediment color. Gravel to sand-sized dropstones (identified and counted in the X-ray images) were present in low abundance throughout this unit.

Unit II is found in the lower section of Holes U1540D and U1540E from ~177.8 to 218.3 m CCSF-A and comprises thick beds of nannofossil ooze with increasing clay content downhole. Unit III spans the lowermost ~10 m from 218.3 to 227.1 m CCSF-A, and consists of heavily altered, brown, calcareous and biosiliceous bearing clay.

Biostratigraphy

Mostly well preserved diatoms, radiolarians, nannofossils, and foraminifers were found in all core catcher samples of Site U1540. Sedimentation rates are higher from the seafloor down to Core U1540D-18H (188 mbsf), but sharply decrease deeper in the hole. Radiolarian, nannofossil, and diatom marker species date the bottom of the hole at >4.5 Ma. Significant reworking was observed in the bottom core of Hole U1540D where several late Miocene diatom species were recognized. Assemblages in the lowermost cores generally indicate warm conditions. Benthic foraminifer diversity increases below 169 mbsf, suggesting warmer bottom water conditions. High abundance of fish teeth in Sample U1540D-21H-CC confirmed much lower sedimentation rates at the base of the sedimentary sequence.

Paleomagnetism

Paleomagnetic measurements were performed to reconstruct the magnetostratigraphy at Site U1540. The natural remanent magnetization (NRM) of archive-half sections from all five holes was demagnetized up to 15 mT, with a few exceptions for cores from Holes U1540D and U1540E, which were demagnetized to 20 mT to verify the reliability of the results. In contrast with the last site, polarity reversal records have been documented at this site. Specifically, geomagnetic reversal events younger than 2.5 Ma are well defined in the records, except for the Cobb Mountain event, and therefore provide excellent age controls for cores above 150 m CCSF-A. However, identifying geomagnetic reversals older than the Gauss–Matuyama reversal (ca. 2.58 Ma) was complicated by occurrences of high-frequency oscillation of polarity reversals in the records within a 20 m interval below ~180 m CCSF-A. A few discrete samples were also investigated to further assess the quality of the NRM record in these sediments. The results suggest that samples at this site tend to have higher coercivities, indicating that NRM records are more stable than those from Site U1539.

Geochemistry

As part of IODP's routine environmental protection and safety monitoring program, headspace gas concentrations were measured in Holes U1540A (Cores 1H–16H), U1540B (2H), and U1540D (15H–21H) at a resolution of one sample per core between 6 and 209.6 mbsf. Near the bottom of Hole U1540D, at 209.6 mbsf, a hard rock piece was collected in a 5 cm³ airtight glass vial, in lieu of available core sediment, and tested for headspace hydrocarbon content. Methane (CH₄) concentrations are low at Site U1540, with values never exceeding 6.44 ppmv. Concentrations of ethene (C₂H₄), ethane (C₂H₆), propene (C₃H₆), and propane (C₃H₈) remain below detection limits.

Fifty-six whole-round samples were collected and measured for routine interstitial water (IW) analyses. Alkalinity and pH in the upper 134 mbsf varied around 3.4 ± 0.5 mM and 7.96 ± 0.07 , respectively. However, a marked decreasing trend is observed in both alkalinity and pH below 157 mbsf. Dissolved Fe and Mn values indicate active scavenging from pore water below 176 mbsf. Influence of hydrothermal fluid on the lower part of the hole can explain some of these observations. Other associated shipboard measurements of major and minor cations and anions largely support the interpretation of hydrothermal influence on pore water chemistry.

Sixty-five carbonate samples were collected for solid phase analysis of inorganic carbon (IC), organic carbon (TOC), and total nitrogen (TN) content at Site U1540. CaCO_3 concentration is relatively high, with a mean value of 46 wt%, reaching a maximum of 93.5 wt% at 15.69 m CCSF-A. TOC comprises a smaller portion of the carbon pool, with an average of 0.39 wt% downhole and two maximum horizons of 0.75 and 0.76 wt% at 28.72 and 98.33 m CCSF-A, respectively. TN occurs in low concentrations at Site U1540, with values never exceeding 0.05 wt%. TOC/TN has an average value of 22.19, which suggests a terrestrial source of organic material to Site U1540.

Physical Properties

Whole-round core sections from Holes U1540A to U1540E were measured for physical properties. In Hole U1540A, natural gamma radiation (NGR) and magnetic susceptibility (MS) show low to medium amplitude variations at a scale of several meters in the upper 75 mbsf. Below between 75 and 120 mbsf, amplitudes decrease in the NGR record and increase in the MS data set. Both MS and NGR increase dramatically to the bottom of Hole U1540D (210.5 mbsf). The NGR and GRA derived bulk density correlates well with discrete density samples ($r^2 = 0.953$). MS and bulk density show an inverse correlation in the Site U1540 records. The Site U1540 P-wave logger (PWL) velocity values generally inversely correlate with bulk density.

The NGR data set was deconvolved to K, Th, and U concentration records for each hole using the provided shipboard MatLab programs. The K and Th records both closely follow the NGR record. The U record in Hole U1540A shows large fluctuations in the top 50 m, and smaller fluctuations thereafter to the bottom of the hole.

Downhole Measurements

Formation temperature measurements were taken with the advanced piston corer temperature tool (APCT-3) in Hole U1540A with Cores 4H (37.5 mbsf), 7H (64.8 mbsf), 10H (93.8 mbsf), 13H (121.8 mbsf), and 16H (150 mbsf); in Hole U1540D with Core 22H (210 mbsf); and in Hole U1540E with Cores 5H (165.5 mbsf) and 8H (194.0 mbsf). The temperature measurement taken with Core U1540D-22H was not reliable because the tool was not able to stay in place for enough time due to the presence of a hard layer at depth. Temperature measurements yielded a linear increase in temperatures downhole between 2.32°C and 4.76°C.

Stratigraphic Correlation

We used Correlator v3.0 and Whole-Round Multisensor Logger/Special Task Multisensor Logger (WRMSL/STMSL), NGR, RGB_blue intensity, and lithologic data to correlate stratigraphic markers between Holes U1540A, U1540B, U1540C, U1540D, and U1540E. After the completion of drilling at Site U1540, we prepared a splice for the site and contributed to the discussion regarding a preliminary age model for Site U1540.

Outreach

This week we reached a total of 2,535 individuals through live broadcasts, website blog posts, and all social media. We made three blog posts on joidesresolution.org, and multiple posts on Facebook (<https://www.facebook.com/joidesresolution>), Twitter (<https://twitter.com/TheJR>), and Instagram (http://instagram.com/joides_resolution). We did two live broadcasts, one with a university in Colombia and one in China.

Technical Support and HSE Activities

Laboratory Activities

- The temperature control knob on the Paleontology Laboratory oven was broken off. The Electronics Specialist replaced the temperature control mechanism. The oven was repaired and put back in service.
- Gantry velocity code modifications were made to display the measurement offset for section-half measurements on the Sample Information screen before saving data to the database.
- Higher than normal N₂ values were observed in CHNS check standards. After several troubleshooting test runs and conversation with Costech technical support, we determined that our V₂O₅ is contaminated. Although we are not sure how this happened, we will run without V₂O₅ for this expedition, as scientists are not interested in sulphur data. Troubleshooting continues, but due to the rough sea state, all weighing activities have been paused.
- Inventory done for scintillation counter and loose N₂ bottles.

Application Support Activities

- Several data edits were done to correct errors in the database.
- Continued work on the Catwalk sampling module.
- More fixes for Correlator Downloader were tested, deployed, and installed at the correlator workstation.

- Made minor changes to some LORE reports (DH_TEMP and PXRf).
- Made minor change to the LORE user interface to properly place some of the expanded report links under their proper “parent” heading.
- Updated some of the “About” text for LORE reports so it accurately represents column changes made over the last few expeditions.
- Result numbers reached their maximum limit for a 32-bit integer, causing data uploads to fail throughout the ship laboratories. The sequence was reset to 6, so that shipboard results will now have key numbers ending in 6. We also worked with developers on shore:
 - to prepare to bring the data home and merge with shore database (which has some old results ending in 6); and
 - to plan how to avoid this in the future by treating all numeric keys as “strings” (text). This will be a major project involving the whole development team.
- The Section Half Imaging Logger (SHIL) lost its calibration and was making all the images green. A backup configuration file was found and restored on the machine. The Imaging Specialist then fine-tuned the instrument until the color of the images looked correct.
- Corrected the Author privileges for the “SCIENTIST” role so that scientists could clear samples from the list in MADMax.
- Discovered that a major cause of MADMax’s slowness in retrieving data from LIMS were the thousands of MAD, MAD_MASS, and PYC tests that have been run over the years on each standard. Therefore, we made a change to MADMax so that it only retrieves tests created within the last year.

I.T. Support Activities

- Commvault backup software license expired during earlier part of week causing all daily backups to stop. Installing the latest renewed license resolved the matter.
- Detected a number of failing keyboards (sticking keys or no response), and replaced three of them.
- Created Expedition 379T email accounts; currently working on finishing server accounts.
- Worked on some *JOIDES Resolution* web page changes.
- Transitioned Bow dome to Sat IS-18 successfully; currently operating off Bow dome. Left Aft dome on Sat IS-23.
- Worked on Risk Assessments for ship environment.

HSE Activities

- Conducted weekly test of safety showers and eyewash stations.
- The weekly fire and abandon ship drills were postponed due to rough seas and bad weather.