

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

Week 5 Report (17–23 June 2019)

Week 5 of the International Ocean Discovery Program (IODP) Expedition 383, Dynamics of the Pacific Antarctic Circumpolar Current (DYNAPACC), was spent coring at Site U1541 followed by transiting on a heavy weather, high seas avoidance course to the northeast. At Site U1541 we cored Holes U1541A (0–9.5 m below seafloor [mbsf] with 9.7 m recovered [102%]), U1541B (0–138.5 mbsf with 129.3 m recovered [94%]), and U1541C (0–118.1 mbsf with 100.4 m recovered [85%]). All times in this report are in ship local time (UTC – 3 h).

Operations

The week started while transiting at reduced speed (7 kt) to Site U1541 under heavy weather and sea conditions. During the transit, weather systems moved in over Site U1541, causing high seas. Therefore, we transited on a weather avoidance course ~100 nmi past the site, then turned back and arrived on site after the system had passed.

The thrusters were lowered and the vessel was in dynamic positioning mode at 0814 h on 17 June 2019. The vessel was positioned over the site coordinates at 0820 h and an advanced piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA) was made up. The seafloor depth was calculated at 3602.4 m below rig floor (mbrf) based on our precision depth recorder and the bit was lowered to a depth of 3597 mbrf to spud Hole U1541A. The first, second, and third attempts brought back empty core barrels even with the bit depth lowered by 5 m each time. The bit was then lowered by 10 m to 3617 mbrf for spudding. Hole U1541A was spudded at 2330 h on 17 June. Core U1541A-1H recovered 9.5 m of sediment, indicating a missed mudline, and the hole was terminated at that point. The time spent on Hole U1541A was 15.75 h (0.75 d).

The bit was raised to 3612.0 mbrf and Hole U1541B was spudded at 0055 h on 18 June. Based on the recovery in Core U1541B-1H, the seafloor was calculated at 3614.4 mbrf (3603.7 m below sea level [mbsl]). Coring continued without incident until a partial stroke was recorded on Core 15H. When the core was recovered, the advanced piston corer temperature tool (APCT-3) cutting shoe showed damage and the driller was unable to get back to bottom. The APC core barrel was retrieved and an XCB barrel was dropped to attempt Core 16X. After drilling for 45 min and advancing only 0.5 m, the barrel was pulled. Core 16X retrieved three large pebble-sized basalt pieces (2–5 cm in diameter) in the core catcher. The bit was pulled out of the hole, clearing the seafloor at 0100 h and ending Hole U1541B.

A total of 16 cores were taken in Hole U1541B. The APC system was used for 15 of these, reaching a depth of 138.0 mbsf before APC refusal and recovering 129.3 m (94%). The XCB system was used for one core, advancing 0.5 m and recovering 0.06 m of basalt (12%). The

APCT-3 was used on Cores U1541B-4H, 7H, 11H, and 15H. Misfires were recorded on Cores 1H, 4H, and 6H, and a partial stroke was registered on Core 15H. Time spent on Hole U1541B was 25 h (1.0 d).

The vessel was offset 20 m to the east of Hole U1541B, the bit was raised to 3608.0 mbrf, and Hole U1541C was spudded at 0325 h on 19 June. The APC system was used to core the hole to a total depth of 118.1 mbsf before coring was terminated at 1805 h on 19 June to allow the vessel to evade approaching heavy weather.

The bit was pulled to the surface, clearing the rotary table at 0140 h on 20 June. The drill collars were laid out and the rig floor was secured for transit at 0204 h on 20 June, ending Hole U1541C and Site U1541. A total of 13 APC cores were taken over a 118.1 m interval with a recovery of 100.4 m (85%). Formation temperature measurements were not taken.

At 0236 h on 20 June, the vessel began a transit to the northeast of Site U1541 to avoid heavy weather headed towards the operational area. By 0000 h on 23 June, the vessel had traveled 772 nmi.

Science Results

Sedimentology

Sediment cores were recovered from three holes at Site U1541 during the last week. Core description and section-half scanning for color reflectance and X-ray images were completed. A spliced sedimentary sequence of ~145 m length has been recovered at Site U1541. It is composed of moderate to heavily bioturbated carbonate-bearing to carbonate-rich diatom ooze, diatom- and carbonate-bearing to diatom-rich calcareous or nannofossil ooze, nearly pure nannofossil ooze, and biogenic oozes with varying concentrations of clay. Based on the distribution of four primary lithofacies, we have divided the Site U1541 stratigraphic sequence into three units, which are further distinguishable by downhole RGB, sediment color reflectance, and physical properties measurements.

The youngest Unit I is subdivided into two subunits, Subunit IA down to ~25 mbsf (27 m core composite depth below seafloor [CCSF-A]) and Subunit IB down to ~63 mbsf (66 m CCSF-A). Subunit IA mainly consists of light gray nannofossil ooze with varying minor components consisting of clay and diatoms interbedded with thinner, less frequent beds of carbonate-bearing or carbonate-rich diatom ooze. Subunit IB consists of a greater proportion of light greenish gray to greenish gray diatom oozes and significantly less clay-bearing lithologies compared to Subunit IA.

Unit II spans from ~63 to ~95 mbsf (66 to 98 m CCSF-A) and mainly consists of interbedded light greenish gray diatom-bearing or diatom-rich nannofossil ooze and white nannofossil ooze.

Subunit IIIA, from ~95 to ~119 mbsf (98.71 to 127.35 m CCSF-A), also consists of diatom- and carbonate-bearing nannofossil ooze and nannofossil ooze, but is mainly distinguished from Unit II by a significant change to pale brown colors. The Unit II/IIIA boundary is also associated with a prominent shift in color reflectance b^* values and an increase in magnetic susceptibility. Subunit IIIB from ~119 to ~137 mbsf (127 to 145 m CCSF-A) consists of dominantly pale yellowish brown to pale orange yellow nannofossil ooze with foraminifers, with minor contributions from diatom-bearing nannofossil ooze and clay-bearing nannofossil ooze. Subunit IIIB is distinguished from Subunit IIIA by the occurrence of diatoms only as a trace component and nannofossil assemblages that are dominated by the two large species *Reticulofenestra pseudoumbilicus* and *Coccolithus pelagicus*.

APC coring terminated with Core 15H in Hole U1541B due to the occurrence of an impenetrable hard rock layer at ~138 mbsf. The XCB system then was deployed to attempt to recover the hard material, and after a 0.5 m advance, three pieces of large pebble-sized basalt (2–5 cm in diameter) were recovered in the core catcher of Core 16X. These very dark bluish basalt clasts are irregular and rounded in shape with a weathered exterior.

Biostratigraphy

Mostly well preserved diatoms, radiolarians, calcareous nannofossils, planktonic and benthic foraminifers, and ostracods were found in the core catcher samples of Hole U1541B. Additional discrete samples were examined from the split core sections from Holes U1541B and U1541C for diatoms, radiolarians, and calcareous nannofossils. Biostratigraphic markers provide an estimated age of ~8 Ma at the base of the cored interval (138.5 mbsf). Sedimentation rates averaged ~2.5 cm/ky in the upper 80 mbsf and decreased to ~1.2 cm/ky on average from 80 mbsf to the bottom. Miocene micropaleontological assemblages contain warmer water taxa. Benthic foraminifers were most abundant in the upper 80 m, then show low abundances.

Paleomagnetism

At Site U1541, paleomagnetic measurements documented geomagnetic reversals dating back to the Late Miocene. The natural remanent magnetization (NRM) of archive-half sections from all three holes were demagnetized up to 20 mT in case a persistent magnetic overprint occurs that may obscure the identification of geomagnetic polarity reversals. The demagnetization of NRM at this site in general suggests that overprints are effectively removed by demagnetization up to 20 mT. The reversal boundaries in the lower Pleistocene to Miocene are often characterized by sharp transitions, whereas the signal for the most recent reversal boundaries (<1.1 Ma) is more noisy.

Geochemistry

Thirty-seven whole-round samples from Site U1541 were squeezed for interstitial water (IW). The IW samples were analyzed for salinity, alkalinity, pH, chlorinity (in triplicate), phosphate,

ammonium, silica, and major and minor cations and anions using ion chromatography and inductively coupled plasma–atomic emission spectroscopy (ICP-AES). IW samples below 80 mbsf in Hole U1541B show influence of hydrothermal fluids. This is similar to what we observed below 150 mbsf at Site U1540 on the eastern side of the East Pacific Rise.

Major and minor element ICP-AES measurements on bulk sediment for Sites U1539 and U1540 are now completed. Bulk sediment geochemical data at Site U1541 show a positive correlation between contents of Al_2O_3 and Fe_2O_3 , MgO , K_2O , and TiO_2 . These relationships appear to indicate that clay mineralogy dominates bulk sediment geochemistry. CaO and SiO_2 , however, do not show any relationship with Al_2O_3 , due to the high abundance of calcareous and biosiliceous microfossils in the cored sediments.

Forty-one CARB (carbonate) samples were collected for solid phase analysis of inorganic carbon (IC), organic carbon (TOC), and total nitrogen (TN) contents at Site U1541. The content of CaCO_3 is relatively high with mean values of ~68 wt%, and a maximum value of 92.67 wt% at 5.19 mbsf. CaCO_3 data follow a similar trend to the RGB blue data downhole. Of the 41 CARB samples collected, 22 have been analyzed for TOC and TN content, and the remaining samples are currently under analysis. TOC comprises a small portion of the total carbon pool relative to TIC, with an average of 0.38 wt% and a maximum value of 0.73 wt% at 8.18 mbsf. TN occurs in very low concentrations at Site U1541, often falling below the instrumental detection limit, with an average value of 0.009 wt% and values never exceeding 0.025 wt%. The ratio of TOC to TN has a relatively high value of 73.3, and reaches a maximum of 295.65 at 5.19 mbsf. These high TOC:TN values suggest a significant amount of terrestrial organic material reaching Site U1541.

Physical Properties

All whole-round core sections from Site U1541 were measured for physical properties. Discrete samples from Hole U1541B were measured for bulk density, porosity, dry density and moisture content, and *P*-wave velocity. The gamma ray density (GRA) data were used to correct the natural gamma radiation (NGR) total counts for density changes, and the NGR data set was deconvolved to K, Th, and U concentrations for each hole. GRA data correlate well with discrete sample bulk density measurements, and *P*-wave discrete measurements correlate well with *P*-wave whole-round measurements. The magnetic susceptibility (MS) record measured on the whole-round cores is consistent with the point measurements on split cores.

The upper 100 m of the GRA record at Site U1541 compares well with the Site U1540 GRA record, but Site U1541 yields a much lower sedimentation rate. Both sites show similar density variations between 1.2 and 1.6 g/cm³. As in the previous sites, MS and NGR values show an opposite correlation to GRA density values but with higher MS in the deeper cores at Site U1541.

Downhole formation temperature measurements were conducted with the APCT-3 in Hole U1541B (Cores 4H, 7H, 11H, and 15H). Combined with discrete thermal conductivity

measurements on 24 core sections of Hole U1541B, results yield low heat flow values of about 18 mW/m², with a geothermal gradient of 19 K/km, broadly consistent with results from the two previous sites.

Stratigraphic Correlation

We used Correlator v3.0 and Whole-Round Multisensor Logger (WRMSL/STMSL), NGR, RGB_Blue intensity, and lithologic data to correlate stratigraphic markers between all holes at Site U1541.

Tie points for the Site U1541 splice were established mostly using the blue RGB channel extracted from the images, but in many cases a combination of measurements was used. We constructed a splice from 0 to 127 m CCSF-A using Holes U1541A, U1541B, and U1541C. Below that depth, we only had cores from Hole U1541B.

Outreach

This week we reached a total of 5,588 individuals through live broadcasts, website blog posts, and all social media. We made one blog post 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 four live broadcasts (New Zealand, Netherlands, Florida, Italy), and conducted a Facebook Live event (Science at Sea broadcast from the *JOIDES Resolution*) hosted by Dena Headlee from the U.S. National Science Foundation.

Technical Support and HSE Activities

Laboratory Activities

- Continued troubleshooting the contaminated V₂O₅ issue for CHNS analyses. We identified a contaminated batch from the vendor and sent them our test results.
- Staff updated manuals in Wiki.
- Participated in Zoom meeting with the Geophysics Laboratory Working Group on June 21.
- Deployed the towed magnetometer on June 22.
- Conducted hard hat inventory for upcoming regulations.
- Conducted chemicals inventory in BFLM, BHAZ, FCL, and MBIO areas.

Application Support Activities

- Work on Catwalk sampling module is ongoing.

- Investigation of various project planning tools is ongoing.
- Section Half Imaging Logger (SHIL) got out of calibration due to user error. Recovered from backup configuration files.
- Fixed an issue with the Drilling Report.
- Investigated a potential MUT issue where uploads from the SHIL rarely occur twice in rapid succession, with the second upload consistently missing one of the file uploads.
- We discovered that several hundred tests exist in the database with no results. The vast majority of these were created on June 12 and 13 (when we had the numerical overflow issue with the results table). We will cancel all empty tests, once we confirm that none of them represent any other problem.

I.T. Support Activities

- Organized laptop inventory for replacement units.
- Obtained new MAK license for Microsoft Visio. License limit threshold exceeded on original license key.
- Implemented various *JOIDES Resolution* web page changes.
- Tested that the Cruise Evaluation web form is working properly.

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.