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

Week 8 Report (7–14 July 2019)

Week 8 of the International Ocean Discovery Program (IODP) Expedition 383, Dynamics of the Pacific Antarctic Circumpolar Current (DYNAPACC), was spent coring at Sites U1542 and U1543. At Site U1542, we completed coring Hole U1542C to 234 m below seafloor (mbsf) for a total recovery of 236.86 m (105%). Subsequently, we cored 202.7 m in Hole U1542D, recovering 205.4 m (101%). At Site U1543, we cored two holes. Hole U1543A was cored to 339.6 mbsf, recovering 350.62 m (103%), and Hole U1543B was cored to 283.1 mbsf, recovering 294.97 m (104%). All times in this report are in ship local time (UTC – 3 h).

Operations

Week 8 of Expedition 383 started while recovering Core U1542C-28H from a depth of 226.0 mbsf. Advanced piston corer (APC) coring continued through Core 30H to 234.0 mbsf. The bit was pulled to 1080 m below rig floor (mbrf), clearing the seafloor at 0420 h on 7 July 2019 and ending Hole U1542C.

A total of 28 cores were taken in Hole U1542C over a 225.0 m interval with two drilled intervals of 4.5 m each. A total of 236.86 m was recovered for a recovery of 105%. Nonmagnetic core barrels were used for all cores, and core orientation measurements were taken until Core 20H, when the orientation tool was removed. A misfire was recorded on Core 8H, and partial strokes were recorded on Cores 10H, 12H, 13H, 16H, 17H, and 20H–30H. The hole was advanced by recovery on all partial strokes.

Hole U1542D was spudded at 0600 h on 7 July, 20 m south of Hole U1542C with the bit positioned at 1107 mbrf. Based on the recovery in Core U1542D-1H, the seafloor was calculated at 1100.7 m below sea level (mbsl). A total of 24 APC cores were taken over a 202.7 m interval with 205.4 m of recovery (101%). Three drilled intervals followed Cores 12H, 22H, and 24H for a total of 11.0 m to help eliminate gaps in core coverage in the previous three holes. Nonmagnetic core barrels were used for all cores, but no orientation or temperature measurements were taken in this hole. Partial strokes were recorded on Cores 10H and 12H–27H. The hole was ended after reaching 213.7 mbsf, and the bit was recovered to the surface, clearing the seafloor at 0245 h and the rotary table at 0545 h on 8 July. The bottom-hole assembly was racked back in the derrick and the rig floor was secured for transit at 0555 h. The ship was switched from dynamic positioning (DP) mode to cruising mode at 0558 h on 8 July, ending Hole U1542D and Site U1542.

The *JOIDES Resolution* made the 119 nmi voyage to Site U1543 in 10.5 h, averaging 11.3 kt. The thrusters were lowered and the ship moved to DP control over the site coordinates at 1717 h

on 8 July. A water depth reading using the precision depth recorder set the preliminary seafloor depth at 3877.4 mbrf for Hole U1543A. The operations plan for Site U1543 (proposed Site ESP-1B) initially called for three holes to a depth of 400 mbsf. This was modified during the expedition due to time lost to weather, shallowing the penetration depth to 250 mbsf for each hole. While coring in Hole U1543A, it was decided to continue deepening the hole until APC refusal, and only core two holes to APC refusal at this site.

Hole U1543A was spudded at 0325 h on 9 July and coring with the full-length APC system continued to 339.6 mbsf. Coring was terminated after 90,000 lb of overpull was needed to retrieve Core U1543A-36H. The drill string was pulled out of the hole, clearing the seafloor at 1830 h on 11 July. Overall, 36 cores were taken with 103% recovery.

The vessel then was offset 20 m to the east of Hole U1543A, and Hole U1543B was spudded at 2010 h on 11 July. The seafloor depth was calculated at 2876.4 mbrf (3865.3 mbsl) based on the recovery from Core U1543B-1H. Hole U1543B was cored entirely with the APC system, with two drilled intervals used to cover coring gaps between Holes U1543A and U1543B. The first drilled interval for 1.9 m followed Core 1H, and the second for 1.5 m followed Core 23H. Core 33H reached a total depth of 286.5 mbsf. Overall, 31 cores were taken over a 283.1 m interval with 104% recovery.

The bit was retrieved to the surface, clearing the seafloor at 1800 h on 13 July and the rotary table at 0045 h on 14 July. The rig floor was secured for transit at 0110 h, and the *JOIDES Resolution* began transiting to Site U1544 (proposed Site CHI-1C).

Science Results

This week we processed and measured cores and samples from Sites U1542 and U1543, discussed and summarized the results from Site U1542, and worked on the reports from Sites U1542 and U1543.

Sedimentology

All cores from Holes U1543A and U1543B were split into archive and working halves, described lithologically, and X-ray imaged. The upper 120 mbsf of the sedimentary sequence at Site U1543 largely consists of dark greenish gray, silt-bearing clay that contains 10–20 cm thick beds of light gray carbonate-, clay-, and/or diatom-rich nannofossil ooze. Below 120 mbsf, diatom abundance generally increases to diatom-bearing silty clay and diatom ooze with sparse decimeter-scale beds of nannofossil ooze. Diatom mats and dropstones are rare, with the latter often masked by diagenetic overprints in the split core surface. Observations of lithification, secondary carbonate precipitation, and microfracturing occur below 250 mbsf.

Biostratigraphy

All core catcher (CC) and a few additional samples from Site U1543 have been analyzed for the presence of biostratigraphic markers. Our preliminary results, based primarily on diatoms and radiolarians, provide the main source of age control and indicate a continuous Holocene to late Miocene sequence. Carbonate preservation varied strongly throughout Site U1543, with many samples barren of calcareous nannofossils and planktonic foraminifers. However, calcareous nannofossils allowed us to identify useful biostratigraphic events for the upper 1.3 Ma.

Paleomagnetism

We finished measuring all cores collected from Site U1542 and most of the cores from Site U1543. Both sites have exceptional, although contrasting, magnetic properties and records. Site U1542 records an ultra-high resolution Brunhes record with strong but somewhat heterogeneous magnetic properties. In contrast, Site U1543 records a low-resolution record with a fine grained, homogeneous magnetization with minimal overprint that appears to preserve all reversals over the last 7 Ma in general high fidelity. Important geomagnetic and stratigraphic insights are likely to be obtained from both sites.

Geochemistry

Seventy-seven carbonate samples were processed for solid phase analysis of total carbon (TC), inorganic carbon (IC), organic carbon (TOC), and total nitrogen (TN) content at Site U1543. Of the homogenized samples, 67 have been prepared for carbonate analyses and 45 have been prepared for CHNS analyses. Thus far, 14 samples have been analyzed for CHNS, and the remaining analyses are ongoing. TC at Site U1543 has a mean value of 0.96 wt% and a standard deviation of ±1.46 wt%, and TN has a mean value of 0.036 wt% and a standard deviation of ±0.006 wt%. Once TIC, TC, and TN analyses are complete, TOC:TN ratios will be determined.

We completed the standard shipboard analyses of 64 interstitial water (IW) samples collected at Site U1542. At this site, sulfate reduction predominates in the shallow sediment and the sulfate-methane transition zone likely occurs at ~9 mbsf. This is not unusual for continental margin sediments, and is probably due to the location of Site U1542 within a high productivity zone supported by abundant supply of nutrients via continental runoff. At Site U1543, sixty-six whole rounds were collected for IW samples. The majority of the shipboard analyses have been completed, and alkalinity, pH, and chlorinity measurements are ongoing.

Physical Properties

The physical properties data from Site U1542 were cleaned of extensive artifacts created by numerous voids and sediment movement caused by pervasive gas expansion. A comparison between the results of the standard core flow conducted for Hole U1542A, for which temperature was equilibrated before splitting, and for Holes U1542B and U1542C for which cores were processed for physical properties and split immediately after Catwalk processing, revealed that

gas expansion compromised the sediment integrity less when the sections were split sooner before full temperature equilibration. Comparison of the magnetic susceptibility (MS) data measured on the Whole-Round Multisensor Logger (WRMSL) and the Section Half Multisensor Logger (SHMSL) indicates the depth of the WRMSL data needs to be corrected for expansion and voids to be able to align them with SHMSL data.

For Site U1543, we logged and measured all core sections from Hole U1543A and Cores 1H to 25H in Hole U1543B following the routine core flow. One hundred and seventeen thermal conductivity measurements were carried out on whole-round sections (one per core), and 101 discrete MAD samples were taken from Hole U1542A.

The WRMSL MS and gamma ray attenuation (GRA) density data from Site U1543 reveal distinct cyclicity downhole. These patterns correlate well with lithological changes, and are related to changes in terrigenous sediment supply and productivity variations, providing a promising record of Miocene to Pleistocene climatic and oceanographic changes. GRA density at Site U1543 yields values between 1.3 and 1.8 g/cm^3, significantly lower than at Site U1542, whereas MS values mostly range between 30 and 200 IU. Both GRA density and MS show decreases in amplitude around 140–180 mbsf, and a trend towards lower values around 1.3 to 1.5 g/cm^3 and 5–120 IU, respectively, indicating a changing lithology, potentially with higher amounts of marine biogenic components. The values point to significant influence of lithogenic material at Site U1543.

The advanced piston corer temperature tool (APCT-3) was deployed successfully seven times in Hole U1543A to obtain formation temperature measurements. Temperature increases from 1.81°C to 5.24°C between 35.6 and 206.6 mbsf.

Stratigraphic Correlation

We used Correlator v3.0 with STMSL/WRMSL MS and density, natural gamma ray (NGR), SHMSL b* color reflectance, and MS data to generate splices for Sites U1542 and U1543.

At Site U1542, gas expansion created voids and cracks that often offset sediment positions between whole-round and section-half measurements. For this reason, Site U1542 tie points were established mostly using SHMSL MS and b* data. We constructed the Site U1542 splice from 0 to 231.69 m core composite depth below seafloor (CCSF-A) using three holes (U1542A, U1542C, and U1542D). However, the splice contains two gaps due to coring disturbance, one at 96.58 and the other at 208.49 m CCSF-A.

At Site U1543, we constructed a preliminary splice from 0 to 324.3 m CCSF-A using Holes U1543A and U1543B. The splice contains one gap at 197.1 m CCSF-A because Core U1543A-20H was highly disturbed and could not be used in the splice. We will finalize the Site U1543 splice upon completion of measurements from Hole U1543B.

Outreach

This week we reached a total of ~2,854 individuals through live Zoom broadcasts, website blog posts, and social media. We also reached 10,000 Facebook followers!

Technical Support and HSE Activities

Laboratory Activities

- We encountered pressurized core material below ~120 mbsf in Hole U1543A. Approximately 50% of the cores ended with the liner shattered. The shattering usually happened while drilling holes on the liner to release the gas or while cutting the sections. We tried various methods to reduce the core shattering, including warming the cores up with a heat gun (non-uniform heating around the core liner) or hot water (more uniform heating around liner) or letting the core equilibrate on the catwalk for 20–30 min after retrieval before drilling holes to release pressure, and then cutting sections slowly with a hacksaw. The "hot water method" seemed to cause the core to squirt more profusely out through the holes after they were drilled into the liner, likely because of a more abrupt temperature change in the core as the temperature of hot water coming out of the hose could not be regulated. Ultimately, we could not conclude which method worked better as the liner shattering seem to occur randomly. It is worth mentioning that a new core liner box was used for Site U1543, adding also the possibility that the material defects on the new liners could have contributed to the liner shattering problem.
- As in other cores, staff observed a few small gas pockets in Core U1543B-25H, but when cutting the core slowly with a hacksaw between Sections 3 and 4, the liner exploded. Luckily, no one was injured, but some core material dropped onto the Catwalk floor. Since the sediment was dry and cohesive, the technical staff were able to piece together the majority of the dropped material and preserve the core. After this incident, only essential personnel were allowed on the Catwalk for the rest of the hole. All staff working with cores on the Catwalk were required to wear face shields in addition to safety glasses, ear plugs, and string-knitted gloves over nitrile gloves.
- The large air conditioning (AC) unit was installed in the RadVan and is operating. The plumbing for the small AC requires several fittings that are unavailable aboard. Ship engineers requested IODP to arrange a service call during the San Diego port call.
- The end-of-expedition schedule was circulated.
- Ship crew repaired the broken pressure casing for the core orientation tool.

Application Support Activities

- Continued development of Catwalk sampling application.

- Investigated issues with the Alkalinity application, which were caused by a device failure.
- Removed project 999 from database and updated MUT, SampleMaster, DESClogik, Spreadsheet uploader, and other data uploader applications.
- All applications reset to current expedition at startup (rather than remembering what the project setting was before).
- All applications use a new "polling notifier" control to periodically (i.e., every 15 min) check to see if the project setting matches the current project in the database. If it does not, a link is shown at the top of the application's window that lets the user reset to the current expedition.
- MUT will pop to the front, and/or unminimize itself when this notification is shown.
- These changes are complete, and minimally tested by the developer, but not deployed.
- Corrected a Drilling Report issue.
- Started gathering and preparing data files from Chilean Sites U1542 and U1543 to provide to Chilean officials. Data files are currently on the DATA1 server.

I.T. Support Activities

- Encountered out-of-disk space error messages on Commvault backup server. Discovered logfiles were consuming all available disk space. Manually cleared logfiles and we are currently investigating why Commvault is not self-cleaning.
- Shipboard personnel reported not receiving incoming calls, outgoing calls worked fine. Opened support request with Rignet for further investigation. Rignet reported equipment failure in Houston, which has been resolved.
- All Expedition 379T and 385T Exchange and OES accounts have been created.
- Exchange server certificates expired causing Outlook clients to stop connecting to server, and Outlook Web Access access reported multiple screens of unsecure website messages. TAMU IT updated certificates, which are good through 2021.

HSE Activities

- Conducted weekly test of safety showers and eyewash stations.
- The abandon ship drill was performed on Sunday.