IODP Expedition 392: Agulhas Plateau Cretaceous Climate

Week 2 Report (13–19 February 2022)

The second week of the International Ocean Discovery Program (IODP) Expedition 392, Agulhas Plateau Cretaceous Climate, included advanced piston corer (APC), half-length advanced piston corer (HLAPC), extended core barrel (XCB), and rotary core barrel (RCB) coring of Site U1579 (proposed primary Site AP-10A). All times in this report are in ship local time (UTC + 2 h).

Operations

Hole U1579A

On 13 February 2022 the rig crew continued tripping pipe to a depth of 2476.1 meters below rig floor (mbrf). At that point, the top drive was picked up and swung into place and preparations were made to spud the hole. The APC core barrel was picked up and run in on the coring line while the vessel was offset a final 20 m to be directly over the desired coordinates. Hole U1579A was spudded at 0440 h from a bit depth of 2508 mbrf and Core U1579A-1H was on deck at 0550 h. The recovery was 8.07 m, resulting in a calculated sea floor depth of 2498.4 meters below sea level (mbsl). APC coring continued through Core 8H at 65.1 meters below seafloor (mbsf). The advanced piston corer temperature tool (APCT-3) was run on Cores 4H and 7H, with poor data on 4H and acceptable data on 7H.

At 1330 h, after firing Core U1579A-9H to 74.6 mbsf, the core barrel became stuck and an overpull of ~70,000 lb was made with no success. The driller drilled over the APC barrel for ~3 m, which was the maximum possible advance due to the block position. Overpull was again applied and the pipe came free, quickly rising 1–2 m. The core barrel was retrieved; however, all that was recovered was a sheared overshot and the sinker bars. The reaction force had sheared the overshot and released it. An attempt was made to fish the core barrel, but despite landing out several times in the top of the bottom-hole assembly (BHA), the barrel was not retrieved. The decision was made to abandon the hole, trip pipe, clear the BHA, and start a new hole. The final bit depth of Hole U1579A was 74.6 mbsf, with the bottom of the lost Core 9H cutting shoe likely at 84.1 mbsf. The drill string was raised and pipe was tripped back to the rig floor with the bit clearing the sea floor at 1735 h. A total of 9 cores were taken in Hole U1579A over an 84.1 m interval with 87% recovery. Total time on Hole U1579A was 33.12 h (1.38 days).

Hole U1579B

On 14 February the coring bit was checked and the BHA was reassembled. The BHA was picked up and run in on the drill pipe to a depth of 2476.1 mbrf at 0630 h. Meanwhile the vessel was offset 20 m north of Site U1579A. Hole U1579B was spudded at 0910 h. Based on the full recovery of Core U1579B-1H, the seafloor was calculated at 2492.9 mbsl. APC coring continued

from Core 2H to 6H at 57.0 mbsf. An APCT-3 shoe was run on Core 4H and the data were good, but it took 70,000 lb of overpull to free the barrel.

At 1515 h, coring was switched from APC to HLAPC for Core U1579B-7F at 57 mbsf. This was just above the zone where the APC barrel had become stuck in Hole U1579A. HLAPC coring continued into 15 February through Core 24F at 136.9 mbsf. Cores 23F and 24F both saw overpull and each core was drilled over approximately 2–2.5 m. Coring was then switched to XCB from Core 25X to 27X, and Hole U1579B reached a final depth of 167.2 mbsf. The XCB was taking 50–55 min to core, too slow to reach the deeper targets in a reasonable time. The decision was made to terminate the hole, offset, and repeat the HLAPC section just completed.

At 1500 h on 15 February the pipe was tripped up out of the hole and the bit cleared the seafloor at 1643 h, ending Hole U1579B. A total of 27 cores were taken in Hole U1579B over a 167.08 m interval with 99% recovery. Total time on Hole U1579B was 40.56 h (1.69 days).

Hole U1579C

The vessel was offset 10 m east and 10 m south. The drill string was spaced out and Hole U1579C was spudded at 1720 h on 15 February, with the water depth from the previous hole (2492.9 mbsl) used as the depth for Hole U1579C. The hole was drilled down with a center bit to 56.5 mbsf. The center bit was retrieved and HLAPC coring began with Core U1579C-2F and continued, with five small (0.5 to 1.5 m) advances without recovery for stratigraphic correlation, to Core 21F at 130.5 mbsf, just above the zone where the limiting overpulls occurred in Hole U1579B. The decision was made to drill down 31.5 m and switch to XCB coring. The drill string drilled down to 162 mbsf, the center bit was retrieved, and an XCB core barrel was dropped. Core 23X, a 5.50 m advance to correct the space-out, was cored in 25 min. Once on deck, however, the core barrel was empty. The XCB cutting shoe had material on it and its jets were clogged, evidence that it had been into the formation, but the material had balled up in front of the drill bit. The pumps were increased from 50 to 65 strokes/min (about ~75 gal/min more).

Recovery in Cores 24X and 25X was poor (<25%), as heave was making it difficult to keep the bit on bottom, and the decision was made to terminate coring at the final depth of 186.9 mbsf. The bit cleared the seafloor at 1815 h on 16 February. During the subsequent pipe trip, the wind and seas began picking up. At 2330 h the pipe trip was completed, but it was too rough to handle the BHA. The BHA was at the rig floor at 2400 h on 16 February to wait on weather (WOW). On 17 February the WOW period ended at 0930 h, with the rig floor able to start disassembling the APC/XCB BHA. The bit cleared the rig floor at 1055 h, ending Hole U1579C. A total of 18 cores were taken in Hole U1579C over a 93.4 m interval with 80% recovery. Total time on Hole U1579C was 42.24 h (1.76 days).

Hole U1579D

The remainder of the four-stand RCB BHA was made up and the pipe trip began at 1345 h on 17 February. Upon completion of the pipe trip at 1800 h, the crew slipped and cut the drilling line. This is done to move the points where the drilling line wraps around the block to avoid fatigue failures. Hole U1579D was spudded at 2124 h using a water depth of 2492.9 mbsl. Hole U1579D was drilled down to 130 mbsf by 0200 h on 18 February. Cores U1579D-2R through 29R at 397.4 mbsf were recovered by the end of 19 February.

Science Results

Site U1579

Science activities during Week 2 included the processing and measurement of core sections and shipboard samples.

Lithostratigraphy

The upper ~330 m of Site U1579 consists primarily of biogenic calcareous sediments (ooze and chalk). The uppermost 125 cm in Hole U1579A and uppermost ~6 m in Hole U1579B are a light gray nannofossil-rich foraminiferal ooze with sand-sized glauconite grains. Below that interval, white nannofossil ooze with rare foraminifers and flecks of pyrite continues downcore to a transition from ooze to chalk at ~149 mbsf in Holes U1579B and U1579C. Nannofossil chalk with varying abundances of clay and foraminifers continues downcore in Hole U1579D through the rest of the ~330 m described thus far. Clay content increases downcore in Hole U1579D. Color ranges from white to light brown to light greenish gray and pink. Color variations typically include discrete centimeter-scale intervals of material with higher clay content, repeating on meter-scale intervals.

Igneous Petrology

No igneous material was recovered this week. Igneous core methodology for visual core descriptions (VCDs) and DESClogik core description templates continued to be developed in conjunction with the Publications Specialist and other laboratory technicians. This included mock-ups of hypothetical descriptions to ensure the successful implementation of these methods.

Micropaleontology

The micropaleontology team analyzed core catcher samples from Holes U1579A–U1579C and Cores U1579D-2R through 27R for calcareous nannofossils, foraminifers, diatoms, and palynomorphs. A few additional samples from working half core sections were analyzed for calcareous nannofossils to refine the position of important boundaries. Calcareous nannofossil assemblages are abundant and moderately to well-preserved throughout the record. Foraminifer preservation also varies, with a few samples showing poor preservation, whereas most samples

are moderately to well-preserved. Planktonic foraminifers are generally abundant and moderately to well-preserved, although a few intervals from the Eocene show poor preservation. Benthic foraminifers are also present but represent less than 10% of the assemblage. Regularly spaced core catcher samples were decalcified for analysis of siliceous and organic microfossils. Sediments from Site U1579 are thus far devoid of siliceous microfossils, with the exception of the Eocene/Oligocene boundary interval, which contains rich assemblages of radiolaria and sparse diatoms. Sediments are consistently devoid of organic microfossils.

Calcareous nannofossil biostratigraphy indicates that Hole U1579A spans from the lowermost Miocene to upper Oligocene. Hole U1579B spans from the lowermost Miocene to just above the Eocene/Oligocene boundary. The XCB spot cores taken in lowermost Hole U1579C span the Eocene–Oligocene transition (EOT), albeit with relatively poor core recovery. Coring in Hole U1579D started above the EOT and had reached the mid-Paleocene at Core U1579D-29R by the end of the week.

Paleomagnetism

Cores U1579A-1H to 8F were oriented with the FlexIT tool. Shipboard measurements included low-field alternating field (AF) demagnetization of archive section halves (0–20 mT), as well as stepwise AF demagnetization of discrete samples. Cores in Holes U1579A–U1579C are primarily composed of calcareous nannofossil ooze that has weak magnetization intensities and made magnetostratigraphic interpretation difficult. In Core U1579D-10R (~210 mbsf) magnetization intensity increases and patterns of reverse and normal polarity are discernable downcore in some core sections. Additional experiments including measurements of bulk magnetic susceptibility, anisotropy of magnetic susceptibility (AMS), isothermal remanent magnetization (IRM) acquisition, and S-ratio calculation were conducted on a subset of discrete specimens to determine rock magnetic properties. The team also started working on interpreting the noisy data.

Stratigraphic Correlation

Four parallel holes were cored over the uppermost 187 mbsf of Site U1579 to retrieve a near-complete stratigraphic succession spanning the lowermost Miocene to uppermost Eocene. Coring in Hole U1579B overlapped with Hole U1579A and extended further down to 167 mbsf. In Hole U1579C, coring started deeper at 56.5 mbsf, to overlap with Cores U1579A-6H to 8H and Cores U1579B-7F to 22F. In Hole U1579D, coring commenced at 130 mbsf, to overlap with Cores U1579B-22F to 27X, as well as Cores U1579C-24X and 25X, and continued beyond this overlap.

The first core of Hole U1579B spanned a different stratigraphy than Core U1579A-1H, and correlation was established between Cores U1579B-2H to U1579A-2H continuing downwards. Drilling of Hole U1579C was successfully guided to recover stratigraphy from the remaining core gaps between Cores U1579A-6H to 8H, and core gaps between Cores U1579B-7F to 22F.

Most core breaks of Hole U1579B were spanned by cores of Hole U1579C, so that only minor stratigraphic gaps remain. Core U1579D-3R and all cores below recovered intervals of stratigraphy not recovered in Cores U1579B-25X to 27X and Cores U1579C-24X and 25X.

Tie points were identified using natural gamma radiation (NGR), magnetic susceptibility (MS), color reflectance, and red-green-blue color space (RGB) data. Across all holes of Site U1579, the most complete and least disturbed intervals of cores were selected, avoiding locations of interstitial water sampling where possible.

Geochemistry

Whole-round (WR) core samples were processed for interstitial water (IW) chemistry, and headspace void gas samples were taken for gas analysis. IW samples were collected at a resolution of two per core in the upper 30 mbsf, one per core to 240 mbsf, and one every other core below 240 mbsf. IW pH and alkalinity, as well as headspace/void gas methane, ethane, and propane concentration were measured in near-real time, and the remaining pore water was subsampled and preserved for additional shipboard and shore-based analyses. Headspace samples were taken at the base of each core for monitoring hydrocarbons. Methane concentrations remain at or below detection limit from the seafloor to around 330 mbsf and increase to around 10 ppmv below this depth. Alkalinity generally increases downcore from near seawater values to maximum values of 15.47 mM. Solid phase carbonate and total carbon measurements are ongoing. Carbon analyses using elemental analyzer (EA) and Coulometer have been completed for Holes U1579A to U1579C and are in progress for Hole U1579D. Carbonate content is around 90% for Holes U1579A to U1579C with increasing variability below ~150 mbsf, reflecting intervals of differing core color and bioturbation intensity (see Lithostratigraphy). Total organic carbon (TOC) is low, ranging between 0.2% and 0.4% for most samples. A few samples contain greater (up to 0.8%) or lower (0%) TOC concentrations, most likely attributed to calculation artifacts. Preparations for IW shipboard measurements of major anions and cations, nutrients (ammonia and phosphate), and elemental geochemistry are ongoing.

Physical Properties

Physical properties of sediments retrieved at Site U1579, Holes U1579A–U1579D, were measured on whole-round sections, half core sections, and discrete samples.

Track measurements

All whole-round sections were analyzed in the Natural Gamma Radiation Logger (NGRL) and select sections were run through the X-Ray Imager. Upon reaching room temperature, all whole-round sections were passed through the Whole-Round Multisensor Logger (WRMSL). During the coring of Hole U1579C, whole-round sections were additionally run though the WRMSL before equilibration to provide low-resolution data for correlation only.

NGR varied around 6 counts/s, with the highest values in Sections U1579B-1H-2 and U1579D-13R-5 of 27.3 and 25.4 counts/s respectively. A maximum WRMSL MS measurement of 79.8 instrument units (IU) is located in Section U1579D-13R-6, but most values varied around 2 IU. WRMSL gamma-ray attenuation (GRA) bulk density values varied between 1.5 and 2.3 g/cm^3, with frequent lower outliers at locations of cracks or other core disturbances. WRMSL *P*-wave velocities averaged 1585 m/s in Holes U1579A and U1579C, and in Cores U1579B-1H to 23F. There is a gradual increase in *P*-wave velocities below ~140 mbsf in Site U1579.

Split sections were passed through the Section Half Multisensor Logger (SHMSL), and selected sections were run through the X-Ray Imager, which resolved visible bioturbation structures. Total reflectance values averaged 79% for Cores U1579A-2H to 8F, Cores U1579B-2H to 24F, and Cores U1579C-2F to 21F. Lower values are observed in the first core of Hole U1579B, and in Hole U1579D. Point MS varied in concert with WRMSL MS.

Discrete measurements

Moisture and density (MAD) analyses were performed on discrete samples (2 per full core, 1 sample per half core). One or two *P*-wave contact velocities were measured per core using the caliper system *P*-wave velocity (PWC) applied to working-half core sections. Thermal conductivity was measured on whole-round sections of soft sediments from Cores U1579A 1H–8F (69 mbsf) using a needle probe and using a section-half puck probe on all other sections in the underlying consolidated sediments.

Bulk density increases from 1.7 g/cm^3 near the seafloor to ~2.0 g/cm^3 at 170 mbsf, following a general trend of porosity reduction from 58% near seafloor to 48% at 170 mbsf. This is consistent with WRMSL GRA density data, although the MAD bulk density values are systematically 0.05–0.10 g/cm^3 lower than GRA densities. *P*-wave caliper velocity data are generally consistent with the WRMSL logger results. A noticeable increase of PWC *P*-wave velocity (from 1800 m/s to 2000 m/s) occurs near 140 mbsf. The velocity increases sharply from Core U1579B-24F to 26X (~140 mbsf), and values of about 2000–2150 m/s are characteristic down to a depth of ~400 mbsf. This corresponds to a lithological change from poorly cemented calcareous ooze to stiffer chalk. Thermal conductivity generally increases downcore from ~1.4 W/(m·K) near the surface to ~1.7 W/(m·K) (~180 mbsf) with a sharp increase at ~140 mbsf, similar to the *P*-wave velocity trend.

Downhole Measurements

Borehole temperature was measured using the APCT-3 tool in Cores U1579A-4H (35 mbsf, poor quality), U1579A-7H (55.6 mbsf), and U1579B-4H (28.5 mbsf). Using the two higher quality equilibrium borehole temperatures (4.4 ± 0.01°C at 28.5 mbsf and 5.9 ± 0.01°C at 55.6 mbsf), a geothermal gradient (~55°C/km) and heat flow (~70 mW/m^2) were calculated using TP-Fit software.

Education and Outreach

The following outreach activities took place during Week 2.

- Posted two blogs with photos on the Expedition 392 page on the *JOIDES Resolution* (JR) website (one written by the Outreach Officer, and one written by a Co-Chief Scientist).
- Posts on Facebook: 10
- Posts on Twitter: 10, plus retweets of scientist posts
- Stories posted on Instagram: 6
- Worked with three scientists on upcoming news and blog publications: Debadrita Jana (Rice News and blog), Thomas Wagner (UK IODP newsletter), Jörg Geldmacher (blog)
- Wrote daily haiku for *3-9-2 haiku* (a proposed postexpedition book) and collected haiku from the science party.
- Completed one ship-to-shore live tour; scheduled 13 future events and rehearsed with scientists hosting tours.
- Conducted interviews with various members of the science party and JRSO technicians.
- Met with former onboard outreach officers (via Zoom) to discuss video tour best practices.

Technical Support and HSE Activities

The following technical support activities took place during Week 2.

Laboratory Activities

- Underway Geophysics and Downhole Logging
    - Installed latest NaviPac version 4.5.5 on the Laboratory Officer computer. Working with Eiva Technical Support and NaviPac vendor to resolve an issue on license that enables remote display of Helmsman.
    - Worked with scientists to integrate core physical property data with reflection seismic profile.
    - Prepared NISKIN water sampler.
    - Set up and tested Sediment Temperature 2 (SET2) tool for possible use.
- Imaging
    - There is an ongoing issue between the Section Half Imaging Logger (SHIL) and MUT with respect to the "roi" and "rgb" load files. Duplicate corrupted files are found in multiple folders and unwanted extensions are made to filenames. Some files are labelled for sections that have not yet been scanned. The SHIL has been reverted to the code from Expedition 396T, which has helped but not eliminated the issue.
    - Current cores contain white nannofossil ooze and extremely faint color tinting is observed in the images. At the next coring break the light angle will be adjusted.

- Chemistry
    - IW samples are being prepared for squeezing in an oxygen-free glove bag.
- Physical Properties
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    - There were numerous communication drops between the GRAS DigiBase and IMS on the WRMSL. The DigiBase was swapped with a spare, but the actual issue may have been a loose USB cable. Further troubleshooting will occur during the next coring break.
    - *P*-wave on the WRMSL was adjusted to allow for the measurement of smaller diameter RCB cores.
    - A new water pusher was made after a crack appeared in the old one.
    - A technician is troubleshooting a portable X-ray fluorescence spectrometer (pXRF) file issue (LIVE vs. REAL time) with Olympus.
- Paleomagnetism
    - Troubleshooting continued on the superconducting rock magnetometer (SRM) in relation to data noise issues for unlocked X and Z SQUIDS. Testing is constrained by core flow. Noise has been observed on the oscilloscope while powering pieces of SRM support equipment. The problem is generally marked depending on what the vessel is doing (e.g., tripping pipe versus coring). Need to determine if this issue is truly electrical or magnetic flux getting to the superconducting quantum interference device (SQUIDS).
- Publications
    - Made improvements to the use of Strater Reload tool to improve workflow and efficiency.
    - Devised an Excel formula to combine and format igneous unit descriptions that are divided into separate columns.
    - Met regularly with igneous petrologists and the DESClogik technician to develop the igneous VCD template.
- Other
    - A new D-Tube tape cutter is being designed and fabricated onboard.
    - The coffee grinder on the Bridge Deck was serviced.
    - IRIS (rig instrumentation system): Work has started on data display for the user interface. Completed tools for assigning data and modifying the appearance of the data display.

Application Support Activities

- MUT-SHIL upload issue: Waiting for a break in coring to deploy a new version of MUT with a longer delay in the LSIMG image analysis before upload.
- Operations reported a strange Unicode symbol appearing in the Latitude and Longitude fields for a hole. The bug seems to be caused when one field uses the Unicode degree

symbol and the other does not. The issue has been resolved and Latitude and Longitude data are formatted correctly now.
- A chemistry technician reported that the Cahn Balance is not uploading weights. A shore-based developer is troubleshooting the issue and data are being uploaded manually until a fix is found.

IT Support Activities

- Continued with Help Desk related tasks, printer maintenance, setup and training of new participants. All participants should now have access to resources needed for the expedition.
- Staged updates from shore and downloaded updates throughout the week to be deployed during Week 3 for macOS, HPE, SonicWall, CrowdStrike, Windows 10, Windows Server, ZENworks, etc. Will coordinate with ship management team.
- Downloaded new updates to ZENworks and prepared standard packages/bundles to push to clients.
- Zero-Day Alert for Google Chrome; version 98.0.4758.102 was pushed out to all Windows and macOS machines to remediate risk.
- Acronis license stopped syncing with the cloud license server and caused backups to stop. Issue was investigated and licenses are now synced properly. Backups now running; will work with Acronis support to figure out why this occurred.

HSE Activities

- All crew completed a daily (every other day beginning 18 February) COVID antigen test. 470 negative tests have been completed for technical and science staff so far.
- Inspected and distributed hydrofluoric acid (HF) safety gear.
- Conducted Sunday safety checks (showers and eye wash stations).
- Conducted life boat introduction classes for new staff.