IODP Expedition 392: Agulhas Plateau Cretaceous Climate

Week 5 Report (6–12 March 2022)

The fifth week of the International Ocean Discovery Program (IODP) Expedition 392, Agulhas Plateau Cretaceous Climate, included rotary core barrel (RCB) coring and downhole logging of Site U1580 (proposed primary Site AP-09B), followed by transit to Site U1581 (proposed primary Site TB-01A), which was cored using the advanced piston corer (APC). All times in this report are in ship local time (UTC + 2 h).

Operations

Week 5 of the expedition began on 6 March 2022 with downhole logging of Hole U1580A. The triple combo tool string logged down to a final tag depth of 524.2 meters below seafloor (mbsf). The tool consisted of the Hostile Environment Natural Gamma Ray Sonde (HNGS), Hostile Environment Litho-Density Sonde (HLDS; with source and caliper), and Magnetic Susceptibility Sonde (MSS). The logging run was completed and the tool was out of the hole at 0630 h on 6 March. For the next run, the Formation MicroScanner (FMS)-sonic suite was made-up and deployed at 0900 h. The tool consisted of the HNGS, Dipole Shear Sonic Imager (DSI), and the FMS. Two passes were conducted, with both tags at ~521.5 mbsf. The tools were back at surface at 1535 h.

Next, the Ultrasonic Borehole Imager (UBI) was made up. The UBI is an add-on rental from Schlumberger, and includes the General Purpose Inclinometry Tool (GPIT) and the UBI. The tool was assembled and the run into the hole started at 1610 h. One pass was completed to 504.5 mbsf. The second pass was aborted due to technical problems, later determined to be the transducer subassembly motor sticking. The UBI logging run was completed with the tools at the surface at 0020 h on 7 March. The tools were laid out, the scaffolding and circulating head were removed, and downhole logging was completed at 0130 h.

The drill pipe was then tripped out of the hole, clearing the rig floor at 0705 h, ending Hole U1580A. A new C-4 RCB bit was prepared and the bottom-hole assembly (BHA) was run to 172.1 meters below rig floor (mbrf) before damage to the drilling line was observed in a routine inspection. The line was slipped and cut (150 ft), the pipe trip resumed, and the drill pipe was lowered to near the seafloor before the vessel completed the 20 m east offset. An RCB core barrel with center bit was installed, and Hole U1580B was spudded at 1710 h from a seafloor depth of 2571.5 mbrf. The hole was drilled to 40.0 mbsf, where the center bit was retrieved and coring commenced with Core U1580B-2R. RCB coring continued through Core 5R at the final depth for Hole U1580B of 77.8 mbsf at 0615 h on 8 March. We then began tripping pipe back to the vessel, clearing the seafloor at 0710 h and the rig floor at 1430 h, ending Hole U1580B. The

rig floor was secured for transit, the thrusters were raised, and the transit to proposed Site TB-01A (Site U1581) began at 1524 h.

After completing the 338 nmi voyage to proposed Site TB-01A (Site U1581), we arrived on site at 2345 h on 9 March. The thrusters were lowered, and the ship was switched to full dynamic positioning (DP) mode at 2357 h.

The APC/extended core barrel (XCB) BHA was assembled and we began tripping pipe to the seafloor. An acoustic positioning beacon was deployed and the precision depth recorder (PDR) indicated that seafloor was 4578.2 meters below sea level (mbsl). We attempted to shoot the first APC core from 4573.8 mbsl; however, this resulted in no recovery (water core). Two additional attempts from 4578.8 and 4583.8 mbsl also resulted in no recovery. Hole U1581A was successfully spudded at 2115 h, recovering 6.88 m, and the seafloor was calculated at 4591.4 mbsl. APC coring continued to 207.2 mbsf (Core U1581A-24H). The advanced piston corer temperature (APCT-3) shoe was run on Cores U1581A-4H, 7H, 10H, and 13H, with good data collected on all four runs. Pressure in the pipe increased while drilling the rathole of Core 24H. A mud sweep was pumped and the core barrel was pulled back to the surface while the crew continued to circulate and condition the hole with an additional two mud sweeps. When the core barrel returned to the rig floor, it had recovered 8.11 m (Core 25G; the designation for a core with an uncertain depth). A fray in the core line was also discovered and this was repaired. Cores 26H to 29H advanced to 233.8 mbsf. We then switched to the half-length advanced piston corer (HLAPC) system. Cores 30F to 31F advanced to 243.2 mbsf.

Science Results

Site U1580

Science activities during the week included the processing and measurement of core sections and shipboard samples for Sites U1580 and U1581. The science party gave Site Summary presentations for Site U1580 and continued to edit reports.

Lithostratigraphy

The lithostratigraphy team completed descriptions for Hole U1580A and started work on the site report. The four cores from Hole U1580B were also described, which included the Paleocene/Eocene boundary. During transit to proposed Site TB-01A (Site U1581), the sedimentology team continued work on the report for Site U1580 and prepared a summary presentation.

A total of 27 cores were described for Hole U1581A, down to 221.5 mbsf. The cores consist of alternating greenish-gray clayey nannofossil ooze (dominant at the top of the succession) and occasional fine-to-medium sand beds that have normal grading. The sand beds become more dominant deeper within the hole down to ~222 mbsf. Silty reddish-brown material is present

between ~197 and 215 mbsf; however, there is an abrupt return to green clayey nannofossil ooze sediments downcore at ~215 mbsf. The thicker sandy intervals are notably soupy in texture and internal structure is absent due to drilling disturbance.

Igneous Petrology

No igneous rocks were recovered this week, but description of basalts continued for Site U1580. Cores U1580A-66R through 68R were described. These consisted of coarse doleritic rocks, some with subophitic clinopyroxenes. The Site U1580 summary presentation was prepared and the report was written.

Micropaleontology

The micropaleontology team finalized analyses of core catcher and split-core samples from Hole U1580A and began synthesizing and interpreting the data. The team also analyzed core catcher samples from Hole U1580B, which was cored to collect a second copy of the Paleocene/Eocene boundary. After the completion of operations at Site U1580, the team began writing the report. After arriving at Site U1581, the micropaleontology team analyzed core catcher and selected split-core section samples from Cores U1581A-1H to 28H (0–231.22 mbsf). Samples from the uppermost 100 m contain abundant and well-preserved nannofossils and benthic and planktonic foraminifers, common diatoms and other siliceous microfossils, and few dinocysts and other palynomorphs. Below 100 mbsf, nannofossils and foraminifers are generally common to abundant but with variable preservation states. Preliminary age constraints suggest that the studied section consists of an expanded Pleistocene to lower Pliocene sequence (~0–4 Ma) between 0 and 200 mbsf. Below ~200 mbsf, there is ~30 m of Miocene sediment that appears to be highly condensed or contains multiple hiatuses.

Paleomagnetism

The paleomagnetism team completed shipboard measurements of all cores from Hole U1580B and Cores U1581A-1H through 16H. At Hole U1580B, cores were RCB drilled and unoriented. At Hole U1581A, all measured cores were APC cored and were oriented with the FlexIT orienting tool. Shipboard measurements included low-field alternating field (AF) demagnetization of archive section halves up to a peak field of 15 mT. Additionally, stepwise AF demagnetization of one or two representative discrete samples per core was also performed. Hole U1580B was drilled to recover an interval near the Paleocene/Eocene boundary, which is entirely encompassed within Chron C24r. Shipboard results show that all cores measured from Hole U1580B yield predominantly positive inclination values and no reversals, consistent with deposition during a reverse chron. No discrete samples were collected from Hole U1580B. After completing measurements for Hole U1580B, the data were analyzed and the results were added to the site report. At Site U1581, numerous clear magnetic reversals were identified from archive half measurements of Cores U1581A-1H to 16H. Results from discrete samples were consistent with archive half measurements. In collaboration with the Micropaleontology group, measured

polarity intervals were correlated to the geomagnetic polarity timescale. It was determined that these cores were deposited in the Pleistocene. Rock magnetic experiments including anisotropy of magnetic susceptibility, bulk susceptibility, and isothermal remanent magnetization (IRM) acquisition were also performed on discrete samples from Hole U1581A.

Stratigraphic Correlation

The composite record for Site U1579 was finalized. The upper 147 m core composite depth below seafloor (CCSF) of the cored succession spans the lower Miocene to lower Oligocene, and from 163.87 to 182.07 m CCSF the lowermost Oligocene to uppermost Eocene section was spliced. For Hole U1579D, core data were successfully correlated to the downhole logging data using natural gamma ray (NGR) data. At Site U1580 an adjusted depth scale was established for the basalt units to avoid overlap of cored material. At Hole U1581A, physical property track data were collected for later correlation and integration with planned coring and logging data in a separate RCB hole.

Geochemistry

Headspace samples were taken at the base of each core of Hole U1581A for monitoring hydrocarbons. Methane concentrations remain below 4 ppmv in for all samples. Sediment samples were analyzed for carbonate content for Cores U1581A-1H to 27H. Carbonate content ranges from 0.01% to 83.4%. Sediment samples are being prepared for analysis for total carbon on the elemental analyzer. Following inconsistent results, maintenance work continued on the source rock analyzer (SRA).

Samples for interstitial water (IW) were taken in Hole U1581A. Two IW samples were taken per core in Cores U1581A-1H and 4H, and three IW samples were taken per core in Cores 2H and 3H. Below Core 4H, one IW sample was collected approximately every 10 m. Alkalinity increases from the surface to Core 9H (~74 mbsf) and begins to decrease in Core 14H (~122 mbsf). A minimum alkalinity value of 1.438 was reached at 277.5 mbsf.

Physical Properties

Physical property measurements on whole-round sections, half core sections, and discrete samples from Holes U1580A and U1580B were completed. Cores from Hole U1581A were processed up to Core U1581A-27H.

In Hole U1580A, high magnetic susceptibility (MS) and NGR values in the deeper sediments correlates with tuffaceous and volcaniclastic layers. The overall higher *P*-wave velocity (PWV), greater density, and color change in this interval are attributed to the diagenetic change of ooze to chalk and to an increase in clay content. Exceptional peaks in NGR were observed in a few dark layers. An exception from the expected change in physical properties downcore was recorded for the potassium enriched zeolitic sandstone to claystone interval of Lithostratigraphic

Subunit IIIa of Hole U1580A. Hole U1580B shows small variations in MS, NGR, PWV, and density, similar to what was observed in the parallel section at Hole U1580A.

At Hole U1581A, density increases from 1.6 to 2.1 g/cm^3 from Core U1581A-1H to 27H. Intercalated turbiditic layers can be distinguished based on physical property data by sudden increases in density and drops in MS. Stronger variations in physical properties at Hole U1581A below Core 12H are related to the occurrence of decimeter- to meter-scale sandy intervals.

Downhole Measurements

Downhole logging of Hole U1580A was performed this week. Caliper measurements revealed good to excellent conditions for logging the borehole, with little evidence for zones of washout observed. Three logging runs included the deployment of tool strings in the following order: the triple combo, the FMS-sonic, and the UBI. Logging speeds were decreased to ~900 ft/h for the main pass of the triple combo string to acquire higher resolution data. During the second logging run, the DSI was run in anisotropic mode to obtain slow and fast secondary/shear wave (*S*-wave) directions in the horizontal plane. The FMS-sonic and UBI data were collected during two main passes each to improve 360° imaging of the borehole. Raw logging data were processed onshore at the Lamont-Doherty Earth Observatory to verify data quality and convert raw logging data from the depth scale of mbrf to a wireline matched seafloor (WMSF) depth scale. The triple combo and FMS-sonic logging runs spanned the interval from ~10 m above the total depth for Hole U1580A (~3096 mbrf, base of logging) to the BHA, which was retracted to ~81 mbsf (2651 mbrf).

Four formation temperatures were measured in Hole U1581A using the APCT-3. The temperatures provided a constraint on the geothermal gradient in the Transkei Basin and will be combined with thermal conductivity measurements to calculate local heat flow.

Education and Outreach

The following outreach activities took place during Week 5:

- 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 Co-Chief Scientist Gabriele Uenzelmann-Neben).
- Posts on Facebook: 7
- Posts on Twitter: 8, plus retweets of scientist posts
- Stories posted on Instagram: 1
- Worked with one scientist on an upcoming article: Allyson Tessin (Kent State Magazine)
- Wrote haiku for *3-9-2 haiku* (a proposed postexpedition book) and collected haiku from the science party. Held a haiku workshop.
- Completed 9 ship-to-shore live tours; scheduled 12 events for the coming weeks.
- Conducted interviews with various members of the science party and JRSO technicians.

Technical Support and HSE Activities

The following technical support activities took place during Week 5.

Laboratory Activities

- Underway Geophysics and Downhole Logging
    - Bathymetric and magnetic data (outside the Exclusive Economic Zone) was collected on transit between sites.
- Physical Properties
    - The DigiBase on the gamma ray attenuation (GRA) bulk density tool that was removed earlier in the expedition was reinstalled. After successfully running for a short period, it failed again. The USB cable was changed out and the system has been running without further issue.
- Paleomagnetism
    - Troubleshooting continued on the superconducting rock magnetometer (SRM) in relation to data noise issues.
    - IM10-30 high-field pulse magnetizer saw was used this week.
- Chemistry
    - Maintenance was performed on the SRA in an attempt to improve data quality.
- Publications
    - T-shirt design contest is underway.
- RigWATCH
    - To bypass a suspected section of bad signal cable, a temporary cable installation for the top drive's torque and rotation per minute signals was installed. However, the issue remained and may not be resolved until the RigWATCH junction box and cabling is replaced. Materials are being ordered for replacement during the next transit/tie up.
    - The vibration isolated television (VIT) is under maintenance, with a software upgrade and reconfiguration of the serial port. The center LED light continues to have intermittent issues but occasionally responds to commands, confirming that the serial port settings are correct and that the software command is sent correctly.
- IRIS
    - Work continued on the Driller's interface, specifically testing depth tracking and the slip/on bottom status.
    - The project is waiting for developers to complete the Collector application and there is currently still no success with uploading data.

Application Support Activities

- The uploader for downhole temperature measurements was throwing an error on login. The issue was fixed and a new version was deployed.

- Intermittent errors were occurring with the ImageCapture software. The currently implemented work around requires a restart and we are currently waiting on shore developers for additional information.

IT Support Activities

- The CrowdStrike Falcon Sensor continues to alert us about potential risks; however, there have been a large number of detections that are "false positives." Staff aboard the ship have been helping to resolve these detections and shore IT support is working on additional solution to reduce the volume of false positives.
- The label printers in the Chemistry Laboratory were not working properly. It was determined that the printers needed to be cleaned and recalibrated. Printers are now working properly.
- Server and Workstation updates this week were successful and will continue next week.

HSE Activities

- Conducted Sunday safety checks (showers and eye wash).