IODP Expedition 378: South Pacific Paleogene Climate

Week 3 Report (19–25 January 2020)

Operations

This week we (1) cored two holes with the RCB (rotary core barrel) system and (2) started coring a fifth hole with the advanced piston corer/extended core barrel (APC/XCB) system.

Hole U1553C

A four-stand RCB bottom-hole assembly (BHA) was made up and deployed to a depth of 1193 m below sea level (mbsl). Hole U1553C was spudded at 0010 h on 19 January 2020 and drilled ahead without core recovery to 234.0 mbsf. The center bit was pulled and RCB coring began.

Half advances (~5 m) were used on Cores U1553C-6R, 7R, 9R to 16R, 19R, and 20R in an effort to maximize recovery. Half advances were also used on Cores 29R to 32R in an effort to optimize the capture of the Paleocene/Eocene Thermal Maximum (PETM). Cores 40R to 43R were cored without liners in the core barrel in an effort to improve recovery. An anomalously low C_1/C_2 hydrocarbon ratio in Core 43R caused Core 44R to be pulled after a 2.7 m advance in order to verify the values. With anomalously low C_1/C_2 ratios in consecutive cores, the decision was made to terminate coring 567.5 mbsf. The bit was recovered to the surface, clearing the seafloor at 0105 h on 22 January, and ending Hole U1553C.

A total of 43 cores were taken over a 334.6 m interval with 47.4% recovery. Total depth for Hole U1553C was 567.5 mbsf and total time was 82.75 h (3.4 d).

Hole U1553D

A new bit was installed on the RCB BHA and deployed to 1193 mbsl to begin Hole U1553D. Hole U1553D was spudded at 0845 h on 22 January and drilled ahead to 178.3 mbsf. The center bit was pulled and the SET2 temperature probe was lowered to obtain a fourth temperature measurement with the goal of refining the thermal gradient at Site U1553.

After recovering the Sediment Temperature 2 (SET2) probe, the center bit was again deployed and the hole was drilled to 399.4 mbsf. The center bit was again pulled and an RCB core barrel was deployed. Cores U1553D-11R to 17R were cored without using liners to improve recovery.

During coring operations, clearance was provided by the Environmental Protection and Safety Panel (EPSP) to advance Hole U1553D two cores deeper than Hole U1553C. This clearance was conditional and based on waiting for the results of headspace gas analysis prior to taking the next core. Coring was paused after Core U1553D-19R to allow time for headspace gas analysis before proceeding. Coring was terminated at the Co-Chief Scientists' request after Core 20R at

584.3 mbsf. The bit was recovered, clearing the seafloor at 2355 h on 24 January, and ending Hole U1553D.

A total of 19 cores were taken over a 184.9 m interval with 53.0% recovery. Total depth for Hole U1553D was 584.3 mbsf and total time was 72.00 h (3.0 d).

Hole U1553E

An APC/XCB BHA was made up and deployed to 1187 mbsl and Hole U1553E was spudded at 0845 h on 25 January. Based on recovery from Core U1553E-1H, the seafloor was calculated at 1221.3 mbsl.

Coring continued with the full-length APC system through Core U1553E-14H at 119.4 mbsf. One XCB core was taken from 119.4 to 129.1 mbsf in order to capture a hard interval encountered in all previous holes at the site. The APC system was then deployed for Core 16H to a depth of 138.6 mbsf. The XCB was deployed from 138.6 to 188.8 mbsf, with Core 22X recovered at midnight on 25 January. Half advances were used on Cores 21X and 22X (177.8 to 188.8 mbsf) to improve recovery.

Science Results

Site U1553

Science activities during the week included the continued processing and measurement of Site U1553 core sections and shipboard samples, analysis of Hole U1553A and U1553B core data, and working on the Site U1553 reports for the expedition *Proceedings* volume. Each laboratory group presented initial results from Holes U1553A and U1553B.

Lithostratigraphy

Sediments from Holes U1553B and U1553E confirmed the stratigraphy observed in Hole U1553A. A thin veneer of Pleistocene sediments overlies Oligocene nannofossil ooze, which transitions to chalk at ~155 mbsf. X-ray diffraction, smear slide, and thin section analyses have confirmed the presence of calcite, pyrite, glauconite, quartz, chlorite, and barite within this unit. Holes U1553C and U1553D recovered nannofossil chalk with foraminifers that lithifies to a bluish limestone by ~446 mbsf in Hole U1553C. Throughout both units, ichnofossils such as *Teichichnus* and *Chondrites* are abundant. Thin green laminations are visible throughout the chalk, as are dark patches of pyrite and chert nodules. In Core U1553C-35R, sediments transition to a siliciclastic lithology that has low carbonate abundance. This unit is characterized by a grey to black color, with abundant bioturbation and ichnofossils, crystalline pyrite, larger bathyal benthic foraminifers, and alteration between silt and sand-sized materials. This unit also has a hydrocarbon odor and a sheen is visible on the core section-half surface.

Biostratigraphy

Analysis of microfossil assemblages from Holes U1553C and U1553D indicates that the top of Hole U1553C is late Eocene in age and the top of Hole U1553D is middle Eocene. The Paleocene/Eocene boundary was identified within Cores U1553C-31R and U1553D-7R. The Cretaceous/Paleogene boundary was not identified in any core. Evidence from sparse nannofossil occurrences suggests that the base of deeper Hole U1553D (~584 mbsf) is early Paleocene. Calcareous nannofossil, foraminifer, and radiolarian assemblages provide good age control in the middle and late early Eocene. Abundance and preservation of radiolarians and foraminifers is poor in the Paleocene through earliest Eocene. Calcareous nannofossil abundance is low and preservation is poor below the upper Paleocene. Benthic foraminifer assemblages indicate that the sediments were deposited in lower bathyal depths during the Eocene and midbathyal depths during the Paleocene.

Paleomagnetism

The magnetization of Holes U1553C, U1553D, and U1553E was weak and close to the background level of the superconducting rock magnetometer (SRM), similar to Holes U1553A and U1553B. Six representative discrete samples from different lithologies were demagnetized, using both alternating field (AF; two samples) and thermal treatments (four samples). The AF demagnetization behaviors are similar to those from Holes U1553A and U1553B. During the thermal treatments, samples from lithologies of varying color (greenish gray to light gray or from dark gray to lighter gray) displayed large movement in magnetic direction. The distinctively dark carbonaceous mudstones appeared different (similar to bleaching) following heating at 100°C.

The anisotropy of magnetic susceptibility (AMS) of 86 discrete samples was measured with an AGICO KLY-4s Kappabridge. The minimum principal eigenvector (V3) shows steep inclinations below ~437 mbsf in Hole U1553C, which may be attributed to sediment compaction and suggests a relatively static depositional environment. In contrast, the minimum susceptibility axis of the discrete samples from Holes U1553A and U1553B above 437 mbsf is not perpendicular to bedding. The SRM was idle for ~8 h on 25–26 January due to a chilled water shutdown.

Geochemistry

Headspace gas samples were collected and measured for all cores in Hole U1553C and in Cores U1553D-7R to 20R. Methane, ethane, and other higher hydrocarbons were detected in Hole U1553C, including low C_1/C_2 ratios in the bottom of Hole U1553C. Reevaluation of the results followed by conditioning and recalibration of the gas chromatograph indicated a previous underestimation (~15%) of methane. Analysis of bulk sediment samples were completed for calcium carbonate and total carbon. Source rock analysis on six bulk sediment samples from Cores U1553C-42R to 44R indicate low maturity of the organic matter. Interstitial water analysis for ions, nutrients (i.e., phosphate and ammonia), alkalinity, and pH are complete. Inductively

coupled plasma spectroscopy and salinity measurements for all liquid samples are nearing completion and evaluation of the data continues.

Physical Properties and Downhole Measurements

Whole-round (WR) core sections from Holes U1553C and U1553D were measured for gamma ray attenuation (GRA) density and magnetic susceptibility (MS) on the Whole-Round Multisensor Logger (WRMSL) at 2.5 cm resolution. Hole U1553E cores were also analyzed on the WRMSL track, with the additional measurement of *P*-wave velocity for Cores U1553E-1H to 16H. For Cores U1553C-31R to 33R and all cores from Holes U1553D and U1553E, GRA and MS were measured prior to thermal equilibrium on the Special Task Multisensor Logger (STMSL) at 5 cm resolution for instantaneous stratigraphic correlation. All WR core sections were measured on the Natural Gamma Radiation Logger (NGRL) at 10 cm resolution and imaged on the X-ray image logger. Moisture and density (MAD) samples were taken in almost every core from Hole U1553C, except where concern over critical intervals or drilling disturbance prohibited sampling. MAD samples were also taken from Cores U1553D-19R and 20R, where the depth of Hole U1553D exceeded that of Hole U1553C. Nondestructive discrete *P*-wave measurements were made on every core in Hole U1553C starting with Core 3R. A substantial increase in NGR counts per second (counts/s) and a decrease in GRA and MAD bulk density corresponds to the lithologic change observed in Holes U1553C and U1553D around ~475 mbsf.

Stratigraphic Correlation

We examined the STMSL, WRMSL, and NGR data from Holes U1553C and U1553D, especially in the interval immediately above, below, and through the PETM. Although we obtained a good correlation, it is not robust because both holes include intervals with insufficient data as a result of the lithology type or incomplete recovery. APC coring in Hole U1553E reinforced some of the tie points suggested for Holes U1553A and U1553B in the upper ~120 m, but some of the deeper high-carbonate intervals that were poorly recovered in the XCB cores precluded deeper connections except for several, floating intervals.

Outreach

The following outreach activities took place during Week 3.

Social Media

Platform	Number of posts	Analytics	Notes
Facebook	14 posts	9.3k reach (down 3.2k), 24 new followers; 4k engagements (down 3.3k)	1 Facebook Live event, 475 engagements
Instagram	48 posts	27k (up 2k), 3.8k reach (up 1.2k); +15 followers net	
Twitter	29 tweets	35 new followers; 660 engagements (down 14)	

Ship-to-Shore Broadcasts

Group	Number of people	Notes
Facebook live	18 live	13 min of live uploaded as video; 1.2K views
Ohio, USA	53	
Missouri, USA	22	
Maryland, USA	36	
Maryland, USA	36	
Illinois, USA	63	

Website/Blogs

- A Chinese news article entitled "Riding waves in South Pacific, What kind of discovery will JR bring in Expedition 378?" was posted on pages of China Meteorological Administration, China Internet Information Center, Xinhuanet, Particle media etc. http://www.cma.gov.cn/2011xwzx/2011xmtjj/202001/t20200117_545074.html
- A Chinese article entitled "Sailing Notes 2: Captain where are we? IODP EXP378" was posted on the IODP-China official website. http://www.iodp-china.org/show.aspx?info_lb=3&flag=3&info_id=667

Other

- One more audio interview done; drafts of promo and first two podcast episodes.
- Three more blog posts sent to Otago Museum blog.
- New Zealand Radio interviews: OARsome Morning Show: https://www.accessmedia.nz/Player.aspx?eid=2c182ec7-89da-4128-bd09-e48c3e0de143 and Radio 1 mornings with Jamie Green.
- One more article sent to IODP-China Office.

Technical Support and HSE Activities

The following technical support activities took place during Week 3.

Laboratory Port Call and Transit Activities

- Processed cores and samples from Holes U1553C, U1553D, and U1553E.
- Fabricated a decapping tool with the 3D printer for the powder sample cups used with the portable X-ray fluorescence spectrometer (pXRF). The tool allows the caps on the sample cups to be removed easily so they can be reused.

Application Support Activities

- Code changes complete for KappaBridge. User testing will begin during transit.
- The Section Half Imaging Logger refused to connect to the database and was fixed.
- Helped Publications Specialist with the creation of a core composite with more than 10 sections. A new image was created and uploaded manually while the issue was changed.
- Helped DESC technician with a ValueListManager problem.
- The Driller's Sample Master module had an issue with a core that was entered and uploaded, but still showed a red row.
- Lazer Katjie has a sort issue for where we have more than 10 core sections. Work continues on this issue.
- LIMS2Excel (L2E) failed to execute when the first drilling sample length was not entered. Fixed L2E to display sample info as blank if it is missing.

IT Support Activities

- Discovered through the Microsoft Windows Update Service that patches were not being dispersed.
- Lost internet services on January 23 for ~30 min due to TAMU network issues.
- iPrint web page was not listing available printers for installation. Matter resolved with assistance from vendor by correcting administrator credential issues.
- Telemedicine connection issues resolved. Problem was with the hospital services contracted. They changed their video conferencing setup to something similar to a Zoom session. Ship must contact the hospital first by email or phone to initiate a telemedicine video session.

HSE Activities

- Conducted abandon ship drill.
- Safety shower and eye wash stations were tested.