IODP Expedition 378: South Pacific Paleogene Climate

Week 2 Report (12–18 January 2020)

Operations

This week we (1) completed the transit to our first site, (2) cored two holes with the advanced piston corer/extended core barrel (APC/XCB) system, and (3) started coring a third hole with the rotary core barrel (RCB) system.

Transit to Site U1553

The *JOIDES Resolution* completed the 2249 nmi transit from Fiji to Site U1553 (proposed Site DSDP 277) in 221.5 h (9.2 d). The vessel arrived on site at 1148 h on 15 January 2020, and the thrusters were lowered and the dynamic positioning system was engaged. At 1210 h operations began for Site U1553.

Hole U1553A

The APC/XCB bottom-hole assembly (BHA) was made up and deployed to 1187 m below sea level (mbsl) and the top drive was picked up. We then pumped two "pigs" (pipe cleaning device) through the drill string to remove some of the rust. Based on the precision depth recorder (PDR) reading, the bit was spaced out to 1215 mbsl and Hole U1553A was spudded at 2105 h on 15 January. Mudline Core U1553A-1H arrived on deck at 2120 h, recovering 3.08 m. This established a seafloor depth of 1221.2 mbsl.

Coring continued with the full-length APC system until a partial stroke was recorded on Core 15H at 127.5 m below seafloor (mbsf). The XCB system was deployed for a single core (Core U1553A-16X) to penetrate a 1.3 m hard interval. APC coring then continued until refusal at Core 20H, where a drillover with 100,000 lb of overpull was required to free the core barrel. The half-length APC (HLAPC) system was then deployed until refusal at Core 22F where a drillover once again was required to free the core barrel.

We then switched to XCB coring, reaching a total depth of 216.4 mbsf with Core 27X. This had been determined to be the final core for the hole prior to deploying the barrel. However, while cutting the core, the driller noticed an increase in top drive torque and the hole was terminated prior to coring the full core length.

After recovering Core 27X, it was determined that the increase in torque was caused by a malfunction in the top drive shaft brake actuator. The drill string was pulled to 1187 mbsl to allow the crew to replace the top drive brake. The bit cleared the seafloor at 2215 h on 16 January, ending Hole U1553A.

A total of 27 cores were taken over a 216.4 m interval with 98.9% recovery. Temperature measurements using the advanced piston corer temperature tool (APCT-3) were taken on Cores 4H, 7H, and 10H, and all full-length APC cores were oriented using the IceField orientation tool. Total time on Hole U1553A was 34.00 h (1.4 d).

Hole U1553B

The top drive brake was repaired and operations resumed at 0915 h on 17 January. The top drive was picked up and Hole U1553B was spudded at 1105 h. The seafloor depth was calculated at 1221.7 mbsl based on recovery of the mudline in Core U1553B-1H. Core U1153B-3H encountered a gravel layer and was a partial stroke. After a full 9.5 m advance, APC coring continued through Core 14H to a depth of 124.8 m. The XCB was then deployed for one core based on the hard interval encountered in Hole U1553A. Core U1553B-15X advanced 6.2 m and APC coring resumed through Core 17H to 150.0 m.

To avoid stuck core barrels, as encountered in Hole U1553A, the XCB system was deployed from 150.0 m until the termination of coring at a total depth of 243.0 mbsf. The bit was then recovered, clearing the seafloor at 1350 h and the rig floor at 1645 h on 18 January, ending Hole U1553B.

A total of 29 cores were taken over a 243.0 m interval with 95.4% recovery. All APC cores were oriented using the IceField orientation tool. Total time on Hole U1553B was 42.50 h (1.8 d), with 10 h spent repairing the top drive.

Hole U1553C

With weather systems moving in, the third APC/XCB hole was deferred in favor of an attempt to reach the deeper objectives with the RCB system. A four-stand RCB BHA was made up and deployed to a depth of 1193 mbsl. The top drive was picked up and the bit spaced out in preparation to spud Hole U1553C.

Science Results

Site U1553

Science activities during the week included laboratory orientations, working on the Methods sections for the expedition *Proceedings* volume that will be published postcruise, and processing and measurements of core sections and shipboard samples.

Lithostratigraphy

At Site U1553, the lithology is dominated by nannofossil ooze with foraminifers, although the uppermost cores (Cores U1553A-1H and U1553B-1H) also contain foraminifer ooze. The

dominant sediment lithology is homogeneous, with abundant pyrite patches, thin layers of green sediment, and periodic large brownish burrows. The green layers tend to be diffuse in the upper cores, but thin laminations become visible around Core U1553A-20H as sediment induration increases. Other minor constituents in the sediment include volcanic ash, calcareous and siliceous sponge spicules, and the occurrence of dinoflagellates and a hard packstone layer observed in Core U1553A-16X. Below ~175 mbsf sediments become more lithified and consist of nannofossil chalk with bioturbation. Core disturbance is common in Section 1 of most cores, and biscuits are observed in XCB cores.

Biostratigraphy

Biostratigraphic examination of calcareous nannofossils, radiolarians, and foraminifers places Core U1553A-1H within the Pleistocene. Core U1553B-1H includes a hiatus between the Oligocene/Pleistocene. Cores U1553A-2H to 23X are upper to lower Oligocene age and Cores U1553A-24X to 26X are late Eocene age. Cores at the bottom of Hole U1553B include late Eocene material, and the Eocene/Oligocene transition preliminarily is identified in Core U1553B-22X. Calcareous nannofossils are abundant in all samples and preservation ranges from good to moderate-poor. Benthic foraminiferal assemblages indicate that sediments at Site U1553 were deposited in lower bathyal depths and in a highly oxygenated environment with the dominance of calcareous epifaunal species. Radiolarians are abundant and very well preserved in Oligocene cores; however, abundance and preservation decrease around the Eocene/Oligocene transition.

Paleomagnetism

Paleomagnetic studies focused on the measurement of natural remanent magnetization (NRM), followed by a series of in-line alternating field (AF) demagnetization steps. Given that the cores are primarily composed of nannofossil ooze and contain a very limited quantity of magnetic minerals (especially primary magnetization carriers), demagnetization peak fields were reduced to 9 or 12 mT. In Hole U1553A, 60 discrete samples were collected and all samples show an initial intensity increase that is interpreted as the removal of a drilling-induced magnetization component. A second increase (at 20–40 mT) suggests a higher coercivity magnetic mineral composition that could not be demagnetized using AF but responds to thermal treatments. Inclinations and declinations were used to determine a preliminary magnetostratigraphy that places Cores U1553A-1H to 8H in the late Oligocene.

Geochemistry

Whole-round (WR) core samples were processed for interstitial water (IW) and headspace void gas samples for gas analysis. IW samples were collected at a resolution of ~6 per core down to 20 m, three per core from 20 to 120 m, and ~1–2 per core below 120 m. Microbiology samples from Cores U1553A-1H to 21F were collected and immediately preserved in formalin or frozen, depending on planned shore-based analyses. 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. No hydrocarbons were detected. IW shipboard measurements also were completed for major anions and cations. Analyses of IW samples for nutrients (ammonia and phosphate) and of solid phases for carbonate content, total carbonate, nitrogen, and sulfur are ongoing. In Hole U1553B Rhizon sampling for interstitial water was collected at a resolution of ~2 per section in Cores U1553B-1H and 2H, 4H to 18X, and 25X. Collection of IW samples resumed for cores in Hole U1553B recovered below the bottom depth of Hole U1553A (216.4 mbsf).

Physical Properties and Downhole Measurements

Whole-round core sections from Holes U1553A and U1553B were measured for density, velocity, magnetic susceptibility (MS), and natural gamma radiation (GRA) at 2.5 cm resolution on the Whole-Round Multisensor Logger (WRMSL). For Hole U1553B these measurements also were made at 5.0 cm resolution on the Special Task Multisensor Logger (STMSL) immediately after arrival from the catwalk to aid stratigraphic correlation. Below Core 23X in Hole U1553A and all Hole U1553B sections were not analyzed for *P*-wave velocity on the WRMSL due to inconsistent measurements resulting from reduced contact with the core liner. All core sections were measured on the Natural Gamma Radiation Logger (NGRL), and imaged on the X-ray imager. In Hole U1553A thermal conductivity was also measured. Moisture and density (MAD), discrete *P*-wave velocity, and shear and compressive strength were measured on working-half core sections. MS and NGR values are generally low throughout Site U1553. Below ~120 m NGR values begin to gradually increase, consistent with compaction, and are more clearly punctuated by what may be regular variations. MAD measurements for Site U1553 increase in density and decrease in porosity downhole, consistent with whole-round GRA density measurements.

Stratigraphic Correlation

The stratigraphic correlators attempted correlation between Holes U1553A and U1553B using a variety of data types from the WRMSL tracks plotted on top of images and color data produced by the Section Half Imaging Logger (SHIL). Some data (notably GRA density) exhibit sufficient variability to create robust ties between holes. Holes U1553A and U1553B have been tentatively correlated and will be refined with the addition of section-half data.

Outreach

The following outreach activities took place during Week 2.

Social Media

Platform	Number of posts	Analytics	Notes
Facebook	12 posts	12.6k page reach (up by 3k from last week); 30 new followers; 7.4k engagements (up 3.7k)	4k reach on "3 things" post, 7k reach on Jenga post
Instagram	7 feed posts; 26 stories	25k impressions (up 6k), 2.6k reach (down 3k)	COSI S2S link was put in bio; clicked 11 times
Twitter	23 tweets (13 original posts)	30 new followers; 674 engagements (down 95)	

Ship-to-Shore Broadcasts

Group	Number of people	Notes
Lycee Francais de Seoul	8	Issues with camera and microphone on their side
Shanghai Natural History Museum	228	With live broadcast on eastday.com
Imperial College	35	
COSI	24	3 connection points total; 2 joined the program late
Taylor Middle School	15	

Website/Blogs

- "Going deep to South Pacific_Navigation diary 1"; released in IODP-China official website: http://www.iodp-china.org/show.aspx?info_lb=3&flag=3&info_id=666
- "The climate constantly warming, will Shanghai be floored in the future?"; released in Shanghai Natural History Museum's official Wechat account and Shanghai popular science website: https://www.shkp.org.cn/content.html?type=wx&id=260979&tag_id=42991
- Shared four blog posts on the expedition webpage: two by Co-Chief Scientists, one by a scientist, one by an Outreach Officer.

Other

- Three blog posts sent to the Otago Museum blog.
- Three podcast interviews completed and audio edited. Episodes are being scripted and finalized.
- Three Women in Science video interviews completed. One edited.
- Three IODP scientists (Larry Krissek, Ann Cook, Liz Griffith) confirmed for COSI Sci Fest event.

Technical Support and HSE Activities

The following technical support activities took place during Week 2.

Laboratory Port Call and Transit Activities

- Processed cores and samples from Holes U1553A and U1553B.
- The pump seized on the Haskris water chiller supporting the X-ray Diffractometer (XRD). The pump and motor were replaced with spares and the chiller is working optimally.
- Continued troubleshooting recurring problems with the QEPro spectrometers on the Section Half Multisensor Logger (SHMSL) until coring operations began. The SHMSL is using the only functional QEPro spectrometer with good results.
- The GEISA AVS is mechanically functional and produces consistent values; however, we do not have a method to calibrate the instrument. The Physical Properties Laboratory scientists are using the handheld Torvane instruments for shear strength measurements.

Application Support Activities

- Deployed corrected version of SampleMaster to Operations, Driller, Core Tech and Core Deck.
- Deployed new version of LIVE so that it now displays color, drilling disturbance intensity, and grain size for Lithostratigraphy Laboratory.
- Rewriting LIMS to Excel (L2E) for Java 11; project underway.
- Modified configuration files for ImageCapture to display drop down menu correctly.
- MUT code for special Kappabridge files in testing.
- Drilling Report code corrected and migrated. Removed confusing alerts from Coreline entry window.

IT Support Activities

- Olympus Handheld pXRF was not working with Windows 10, even though the prior expedition did not experience this issue with Windows 10 and it was confirmed operational. In the interim found the spare Windows 7 laptop with functional software. Will continue investigating issues with Windows 10.

HSE Activities

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