IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 6 Report (27 August–2 September 2017)

Operations

Week 6 began while returning from Auckland to Site U1508. We completed the 302 nmi transit at an average speed of 10.9 kt and arrived at 0600 h on 27 August. Dynamic positioning (DP) was established and the drill floor was cleared for operations at 0712 h. The rotary core barrel (RCB) bottom-hole assembly (BHA) was assembled and deployed to the seafloor and Hole U1508C was initiated ~20 m northwest of Hole U1508B at 1150 h, with a center bit installed in the core barrel.

The plan was to drill to ~480 m DSF, ~20 m above total depth of Hole U1508B, and resume coring. We also decided to spot core two scientifically interesting intervals that had particularly low recovery in Hole U1508B. After drilling without coring to 278 m DSF, we pulled the center bit and collected core from 278 to 292.6 m DSF (Cores U1508C-2R to 4R) at half core intervals. The center bit was deployed again to drill ahead from 292.6 to 316.0 m DSF, before cutting a half core and a full core (6R and 7R) from 316.0 to 330.7 m DSF. The center bit was deployed again and drilling without coring advanced from 330.7 to 450.0 m. At 0730 h on 28 August we retrieved the center bit and resumed RCB coring until penetration rates slowed to ~2 m/h. Although short of the desired target depth, at 0300 h on 31 August we decided to stop coring and conduct wireline logging. Collectively, Cores U1508C-2R to 38R, and the two interspersed drilled intervals, penetrated from 278.0 to 704.5 m and recovered 185.04 m of sediment (65% of cored intervals).

At the end of coring, the hole was cleaned with a 30-barrel high viscosity mud sweep. Next, the rotary shifting tool (RST) was deployed to trigger the mechanical bit release (MBR) and drop the bit at the bottom of the hole (0325 h). The reverse RST was deployed to shift the MBR sleeve back into the circulation position (0430 h). Next, the hole was displaced with 194 barrels of 11.0 ppg mud and the end of the drill string was set at 86.7 m. An additional 10 barrels of mud were pumped to ensure the entire hole was displaced with heavy mud.

At 0745 h on 31 August assembly of the modified triple combo logging tool string began. This was the same configuration as used in Hole U1507B with the exception that no source was installed in the density tool. The logging tools were deployed at 0900 h and data were collected while lowering the tool string to the bottom of the hole. After logging up 128 m for a calibration run, the tools were run back to the bottom of the hole, and the main logging pass began. At ~1230 h the tool string became stuck at ~270 m WSF (wireline depth below seafloor). The logging line was cut at the rig floor and terminated with connectors that would allow assembly of drill pipe over the logging line to wash down and over the logging tools with the open-ended BHA. The logging tools were free at 2105 h. The tool was pulled to 155 m WSF using the T-Bar

procedure, when sufficient logging line had been retrieved to make a connection with the aft coring line, which was used to pull the logging tools to the surface. The logging tools were recovered and cleaned by 0315 h. The drill string was recovered and the end of pipe cleared the rig floor at 0650 h. The positioning beacon was recovered, the rig floor was secured for transit, the thrusters and hydrophones were raised, and the transit to Site U1509 began at 0730 h on 1 September.

We arrived at Site U1509 at 1030 h on 2 September, completing the 273 nmi transit from Site U1508. After lowering thrusters and hydrophones and establishing DP, the rig floor was cleared for operations at 1045 h. While the RCB BHA was being assembled, a seafloor positioning beacon was deployed. The drill string was deployed to just above the seafloor and the top drive was engaged. A "wiper pig" was pumped through the drill pipe in an attempt to remove excessive rust observed during drill string assembly. Hole U1509A was initiated at 2145 h. Cores U1509A-1R through 3R penetrated from the seafloor to 19.4 m and recovered 2.1 m (11%).

Science Results

During week 6 the scientists completed measurements and observations on all cores from Hole U1508C and prepared draft reports for Site U1508. Processed wireline logs for Hole U1508C were received, and the first three cores of U1509A were recovered at the end of the week—no results are available yet. All depths reported are meters CSF-A unless noted otherwise.

Based on the core descriptions from Hole U1508C (278.0–701.9 m), the lithostratigraphic units for Site U1508 were finalized. Lithostratigraphic Unit I (0–90.1 m) consists of coarse-grained bioclastic sand, mostly composed of foraminifera but with intervals of abundant bryozoans. Lithostratigraphic Unit II (90.1–379.3 m) consists of ~290 m of nannofossil ooze with varying amounts of foraminifers, clay, and sponge spicules. The unit is divided into two subunits. Subunit IIA (90.5–201.1 m) is ~111 m of homogeneous nannofossil ooze with foraminifers. Subunit IIB (201.1–379.3 m) is ~178 m of foraminiferal ooze or chalk, interbedded with decimeter-scale nannofossil ooze or chalk. Lithostratigraphic Unit III (379.3–701.9 m) is ~323 m of bioturbated nannofossil chalk with rare centimeter-scale layers of cherty limestone, decreasing in abundance downhole, and millimeter-sized pyrite blebs throughout. This unit is defined by an abrupt decrease in grain size from sand-sized foraminifers dominating in Subunit IIB to nannofossil chalk. From 685.8 m to the bottom of the hole at 701.8 m, light greenish gray nannofossil-rich limestone with decimeter-scale color banding of relatively darker greenish gray was encountered. Pyritization and bioturbation sharply decrease in the limestone interval.

Nannofossil and planktic foraminifera biostratigraphy determined an early Miocene age for Cores U1508C-2R to 4R and 6R. Core 7R records a late Oligocene age. Cores 9R to 12R are of late Eocene age and Cores 13R to 36R are of middle Eocene age. The last two Cores 37R and 38R are early Eocene in age based on nannofossils, planktic foraminifera, and radiolaria.

Reworking of early Paleogene microfossils was observed in samples of late Eocene age. Preservation of all microfossil groups generally declines downhole.

Based on benthic foraminifera, paleodepths were lower bathyal through the Miocene and were possibly as shallow as deep middle bathyal through the late to middle Eocene. Traces of reworked shallow water taxa were observed in Miocene samples. A possible hyperthermal event has been identified by abundant *Aragonia aragonensis* in Cores 20R and 21R.

Palynological analysis of samples from Holes U1508B (n = 5) and U1508C (n = 5) yielded moderate- to well-preserved palynomorphs, predominantly dinocysts. Terrestrial palynomorph content is much lower in the Eocene and early Oligocene than in the late Oligocene–Pliocene. Age-diagnostic dinocyst species corroborate the age constraints as determined by calcareous nannofossils and planktic foraminifera.

The intensity of natural remanent magnetization of most intervals in Hole U1508C is weak, which results in noisy paleomagnetic data. However, reliable paleomagnetic results were obtained from the uppermost interval within Unit IIB (~280–330 m), as well as in the lower part of Unit III (~620–700 m). Magnetostratigraphic interpretation of the lower interval of Hole U1508C is primarily based on data from discrete samples, which exhibit well-defined stable paleomagnetic directions. The reliability of paleomagnetic data of the lower interval is supported by anisotropy of magnetic susceptibility (AMS) data of discrete samples, which indicate well-defined oblate AMS fabric of undisturbed sediments. Integrating paleomagnetic data from Holes U1508B and U1508C with biostratigraphy, a total of 12 paleomagnetic tie points to the geomagnetic polarity timescale were obtained. Magnetostratigraphic results indicate that sediments from Hole U1508C range from Chron C5AB in the middle Miocene to Chron C21r in the middle Eocene.

Physical property measurements on cores from Hole U1508C show an exponential increase in *P*-wave velocity and bulk density with depth. Between 0 and ~200 m, velocity and density gradients are low. A velocity inversion occurs at ~90 m and correlates with a bulk density increase. This unusual trend in physical properties may be due to the presence of sponge spicules in the nannofossil ooze. Between 200 and 380 m, in an interval of clayey ooze and chalk, velocities and densities are 1850–2000 m/s and 1.5 to 1.7 g/cm^3, respectively. Magnetic susceptibility is high within this interval with values up to 200 IU. Natural gamma radiation (NGR) also increases from 15 to 25 counts within this interval. From 380 m to ~700 m, in carbonate rich sediments, velocity and density gradients increase. Densities increase from 1.9 to 2.2 g/cm^3 and *P*-wave velocities increase from 2000 to 2400 m/s between 380 and 660 m. High density, high velocity layers of limestone were recovered between 660 and 700 m, where *P*-wave velocities reach ~3600 m/s and densities reach 2.4 g/cm^3. A significant decrease in rate of penetration occurred in this interval.

A modified triple combo wireline logging tool string was used in Hole U1508C. A high-quality dataset including caliper, NGR, resistivity, and *P*-wave and *S*-wave velocities was acquired from 87 to 660 m WMSF.

A total of 10 interstitial water (IW) samples were collected from Hole U1508C and analyzed. The results generally overlap with those from the lower part of Hole U1508B. Notably, between 280 m and 500 m, the profiles show a major drop in sulfate and major increases in ammonium, strontium, barium, and lithium. The concomitant loss of sulfate and rise in methane at ~500 m suggests a deep zone of oxidation of methane coupled to sulfate reduction, which may explain the abundant macroscopic pyrite observed at this depth interval. An increase in Ca and decreases in Mg and K were recorded in the lower part of Hole U1508C. This is similar to the patterns reported from Sites U1506 and U1507, and could result from the reaction of pore waters with volcanic ash dispersed in the sediment.

Bulk sediment carbonate content varies considerably with depth, having 100 m scale fluctuations between highs of ~95 wt% and lows of ~40 wt%, which relate to the lithostratigraphic units. TOC contents are 0.76 ± 0.36%, without any consistent downhole trend.

Education and Outreach

Ship-to-Shore video outreach events were held with: Pymble Ladies College, in Sydney, New South Wales (Australia), Kenmore State School Year 5 STEM Class, Brisbane (Australia), Tamalpais High School (six presentations), Tamalpais, California (USA), ECORD Summer School, Bremen (Germany), and Cerritos College, Los Angeles (USA). Several science party members and technical personnel participated in these events. A Reddit session was conducted from the ship between 1700 and 1900 h (US EST) on September 1.

Preparations are being carried out for upcoming events, including a videoconference with Lycee Jean d'Alembert (Chile), an introduction to the *JOIDES Resolution* for upcoming E&O officers, New York (USA), Robinson's Secondary High School, Fairfax, Virginia (USA), St. Augustines, Victoria (Australia), Corinda State High School Library, Queensland (Australia), and Cleveland District Primary School, Queensland (Australia). Video tests are planned with Licei Galilei-Oberdan-Petrarca (Italy) and Osterholz-Scharmbeck (Germany).

An edited video covering the drilling process was uploaded to YouTube. A video interview was held with a scientist, and more video footage of the Core Laboratory and drill floor was collected. These videos will be used for uploads during the expedition as well as for postexpedition production. Companies that are interested in obtaining footage after the expedition were contacted.

Technical Support and HSE Activities

Underway Activities

- The starboard high-pressure isolation valve (air supply for seismic sources) failed due to bolt fatigue. The ship's mechanic replaced the valve and the system is back in service.
- Siem Offshore is making plans to remove the starboard high-pressure piping and manifold per IODP request.
- Disassembled the vertical seismic profile signal and air supply hose bundle and made the following repairs:
    - Replaced a damaged signal lead.
    - Replaced tie-off grips.
    - Inspected and repaired electrical splices as necessary.
- Bench tested the Tanner gas injection pump, removed corrosion from motor and pump housing, and repainted the unit.
- Magnetometer and bathymetric data were collected on the transit from Site U1508 to Site U1509.

Laboratory Activities

- Issues with the handheld X-ray fluorescence (XRF)'s corrupted files were resolved by syncing the software version in the XRF appliance with the software on the PC.
- The inventory of consumable supplies has been updated to support the new ICP.

Application Support Activities

- Work continued on the LDAQ Coulometer software.
- Made changes to the thin section report definition builder to correctly download a JSON file.
- Completed changes to the XRF Summary Report so that searches can be made using the splice feature.
- Fixed an issue in the XRF-related web service and added filename as a parameter to the call.
- Updated the QEPro spectrophotometer software to identify data clipping during calibration and automatically adjust the integration time so that a good "white" calibration is obtained.
- Fixed a recurring issue where the gamma ray attenuation (GRA) calibration time is used for the normal sample measurement time instead of the value set by the user.
- Fixed issue with GRA data file where the core diameter was saved as counts/s.

IT Support Activities

- The Remote Alarm Status Panel for the Uninterruptible Power Supply (UPS) requires new plastic button assemblies. The vendor has been contacted for part numbers and pricing. The MCSs worked with Electronic Technicians to replace some of the indicator light bulbs and repair loose wiring. The panel is currently operational.
- The first workstation inventory data has been sent electronically to shore for the new Windows 10 computers and new Macs. The inventory data include hardware and software that exist on each device.
- Work began to create accounts for the science participants of Expedition 369.

HSE Activities

- The weekly fire and lifeboat safety drill was held.
- Staff completed routine checks of laboratory safety systems.