IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 2 Report (30 July–5 August 2017)

Operations

Week 2 of Expedition 371 began on 30 July 2017, the day of departure from the port of Townsville, Australia. The ship was secured for sea, a pilot arrived aboard at 0648 h, and two port tugs arrived to assist with the departure. The last line was released at 0712 h, marking the beginning of the 1167 nmi transit to Site U1506 (proposed Site LHRN-3A).

We arrived at Site U1506 at 1912 h on 3 August 2017 (UTC + 10 h). The thrusters were lowered and the dynamic positioning system was engaged. At 1948 h, the drill floor was cleared for operations, beginning Hole U1506A. At 2033 h, an acoustic beacon was deployed.

The rotary core barrel (RCB) bottom-hole assembly (BHA) was assembled and deployed. Rotary coring was selected because the primary target, a strong reflector, presumably represented a transition to hard rock. All drill string tubulars were strapped and drifted during the pipe trip. The top drive was picked up and a wiper "pig" was pumped through the drill string to clean any debris from the inside of the drill string. The core barrel was deployed and Hole U1506A was spudded at 0600 h on 4 August.

The seafloor depth was determined to be 1494.9 mbsl based on tagging it with the drill string. RCB coring proceeded at 9.5 to 9.7 m intervals through Core U1506A-28R (263.1 m DSF). Core 29R encountered the expected hard formation at 264.6 m DSF. We recovered cores in half intervals (4.5–5.0 m length) below this depth to minimize risk of core loss due to jams in the bit or inner barrel. We obtained an average core recovery of 76% in this depth interval, which contained volcanic rocks.

We decided to stop drilling after Core U1506A-36R, which arrived on the rig floor at 1345 h on 5 August. Total recovery for the 306.1 m drilled at Hole U1506A was 192.38 m (63%). A single 15-barrel mud sweep of high viscosity gel mud was pumped during drilling in this hole. The drill string was retrieved, disassembled, and inspected, the acoustic beacon was recovered, and the rig floor was secured for transit, ending Hole U1506A operations at 1935 h. The time spent on Hole U1506A (and Site U1506) was 47.75 h or 2.0 d.

At 2000 h we were underway to Site U1507 (proposed Site NCTN-8A). We completed 41 nmi of the 286 nmi transit by midnight on 5 August, the end of week 2. We expect to arrive at Site U1507 at 2200 h on 6 August.

Science Results

The lithostratigraphy team examined sediments from Hole U1506A from the top of the hole to the base of Core 28R (0.0–262.0 m CSF-A). The section consists of homogenous white gray moderately bioturbated nannofossil ooze and chalk with foraminifers and scattered micrometer-scale pyrite grains. The transition to chalk occurs starting at Core 26R (~235 m CSF-A) and is characterized by the appearance of burrows (e.g., *Zoophycos, Skolithos, Planolites,* and *Chondrites*), which were not visible in the nannofossil ooze. In addition, subtle decimeter-scale color banding was observed in Core 19R, possibly linked with the appearance of bioturbation and related diagenesis. In Core 28R (253.5 m CSF-A), the chalk transitions to a pale yellow color.

The seven cores containing the sediment-rock contact and the underlying ~31 m of volcanic rocks will be split and described during the transit to Site U1507. Thin sections will be available a few days later for additional descriptions.

The biostratigraphy and paleoenvironment team analyzed samples from all sedimentary core catchers. Cores 1R to 27R are Pleistocene to late Miocene, spanning nannofossil Zones NN20 to NN6 and planktic foraminifer Zones PT1b to M9. Nannofossil and planktic foraminifer age control indicates a late Oligocene age for Core 28R (Zones NN1 and O7, respectively), and thus a very condensed interval representing ~10 Ma. A hiatus spanning from the middle Eocene (NP15b) to the upper Oligocene (NP25) was identified towards the top of Core 29R. All core catcher samples at this site are barren of radiolarians. Samples for palynological analysis were taken and await processing. Ostracod and benthic foraminifer assemblages indicate a lower bathyal paleodepth for Cores 1R to 28R, and upper bathyal for the Eocene interval of Core 29R.

The paleomagnetism team almost completed the measurements of all section halves from Hole U1506A on the superconducting rock magnetometer to obtain a continuous record of remanence after alternating field (AF) demagnetization treatment at 10, 15, and 20 mT. In the nannofossil ooze interval (Cores 1R through 25R), the paleomagnetic directions were not stable, largely due to the RCB coring system that disturbed soft sediments at Site U1506. Stable paleomagnetic directions with several normal and reversed polarities were obtained in the more lithified chalk of Cores 27R through 30R. The basement rock interval below the sedimentary sequence also yields a stable paleomagnetic signal after removing a strong overprint with AF demagnetization at 20 mT. A total of 41 discrete samples were measured with a spinner magnetometer after stepwise AF demagnetization from 10 to 70 mT.

The petrophysics team measured gamma ray attenuation (GRA) bulk density, magnetic susceptibility, *P*-wave velocity, and natural gamma radiation (NGR) on Cores 1R through 34R, as well as thermal conductivity, color reflectance and point magnetic susceptibility, additional *P*-wave velocity, shear strength, and moisture and density (MAD) on Cores 1R through 28R.

GRA bulk density increases from ~1.6 to ~1.8 g/cm^3 in the upper ~180 m at Hole U1506A, then decreases again to ~1.6 g/cm^3 towards the sediment-rock interface at 264.6 m CSF-A, where it

increases sharply to ~2.5 g/cm^3 in the volcanic rocks. The downhole decreasing trend in bulk density is attributed to the decreasing core diameter in that interval. MAD porosity values available thus far gradually decrease from ~63% to ~58% down to ~140 m CSF-A, representative of a normal compaction trend for calcareous ooze. *P*-wave sonic velocity values gradually increase with depth from ~1600 m/s to ~2000 m/s in the sedimentary sequence. Intermittently higher *P*-wave velocity values of ~2200 m/s occur in Cores 26R and 27R, reflecting the diagenetic transition and increasing lithification from nannofossil ooze to nannofossil chalk. Thermal conductivity data show a gradual and increasing trend with depth from 1.1 to 1.4 W/m·K over the top ~250 m.

Magnetic susceptibility is low throughout the sediment section, with few local spikes up to 100 instrument units (IU), whereas the basement rocks have much higher values, up to ~1500 IU. NGR is also generally low in the calcareous sediment sequence, decreasing downhole from ~4 to ~1 cps. A slight increase to 4 cps is observed at 240–264 m CSF-A, and a sharp peak to ~25 cps over ~1 m at the sediment-rock interface at 264.6 m CSF-A. NGR values range from 3 to 9 cps in the volcanic rocks.

The stratigraphic correlation team familiarized themselves with procedures and relevant software. Several sections were run through both Whole-Round Multisensor Loggers available onboard to assess data reproducibility and to optimize data acquisition procedures in preparation for the next sites where near-real time stratigraphic correlation of multiple holes will require the use of both loggers. Data from the two loggers are highly reproducible. The teams also supported the petrophysics team with Hole U1506 measurements by operating the core loggers.

The geochemistry group collected and analyzed 15 interstitial water (IW) samples from Cores 4R through 28R, and one "mudline" sample. Sulfate concentrations decreased from ~29 to ~20 mM at depth. Across this same interval, ammonium concentrations increased from 0 to 150 μM. This likely reflects sulfate reduction of particular organic carbon in the sediments. The product of this reaction, H_2S, once reacting with Fe, also explains the abundant iron sulfide mineral horizons observed in the cores. From the top to the bottom of the sedimentary section, Ca increases from 10.6 to 18.3 mM, and Mg decreases from 52.9 to 36.2 mM. This could reflect reactions between pore water and basement. Headspace gas samples were routinely collected from each core. Hydrocarbon concentrations in all samples were below detection limit. Samples are presently being prepared for solid phase chemistry (i.e., carbonate and organic carbon content).

Education and Outreach

The Education and Outreach Officers spent the week preparing for live outreach events, as well as scheduling media conferencing for radio and television interviews. They ran two "Ship to Shore" video links for education institutes and set up eight live videos to various media outlets. In addition, they confirmed "link up" contacts with schools and conferencing with scientists for

next week's events, and promoted the "Ship to Shore" to education outlets in Australia and New Zealand and social media posts. They are continuing to compile a list of media outlets that have published reports on Expedition 371 as well as images and videos for social media and television media outlets. Two videos covering the coring and drilling process were completed.

Technical Support and HSE Activities

Underway Activities

- Magnetic and bathymetric data were collected on the transit from Townsville to Site U1506 and are being collected on our current transit to Site U1507.
- On the first transit, the magnetometer lost a fin and the protective jacket was damaged. We found a few shark teeth fragments embedded. The magnetometer was repaired for the second transit.
- A Siem Offshore mechanic is working on the port side winch control linkage to ensure the winch will stop when the control lever is in the neutral position.
- We corrected two issues with the WinFrog navigation configuration: 1) *General Projection* was set to "user" instead of "WGS94 UTM" to ensure the program uses the correct projection; and 2) the Kalman filter was turned back on. The Kalman filter is used to smooth the ship's speed data and prevent jitter caused by small errors in GPS fixes. The lack of Kalman filtering was the cause of reports by the other crew about erratic ship speed.
- We are having an issue with the aft GPS receiver dropping offline. The receiver is working and we believe it is a network issue.

Laboratory Activities

- We reorganized wires and rebuilt the computer shelf in the whole-round core logging area on the transit from Townsville.
- The handheld X-ray fluorescence (XRF) scanner was set up in the Downhole Measurements Laboratory for science use. Scientists were given a safety and use introduction and were provided with radiation monitoring rings.

Application Support Activities

- We added the *Max Length* feature to the Special Task Multisensor Logger (STMSL) software. This allows users to designate a shorter length to measure less than the full section length, which is mostly used for igneous rock cores to prevent the measurement of empty liner.
- We assisted many staff and scientists with unlocking their database account and/or resetting their passwords, more than usual for the start of an expedition. We suspect that

something caused many accounts to be locked and that people interpreted this as not knowing their password.

- When the microscope workstations were upgraded to Windows 10, the microscope configuration files for the Image Capture software were not retained. Image Capture was reinstalled with the default configuration. The Imaging Specialist assisted with resetting the configurations with values appropriate for the different microscopes.
- We removed some old data from Expedition 368 from the Asset Manager (ASMAN) because they were causing problems.
- Work on the ongoing *Coulometer* project continues.
- We resolved issues with IODP software displaying improperly when the system font size was set to something other than default.
- Upgraded software was deployed for the uploader program MUT, SampleMaster, and Lims2Excel.
- We fixed a problem with the data display program LIVE related to a recent change made on shore.
- We identified and replaced a bad cable that was causing data uploads from the Section Half Imaging Logger to fail.

IT Support Activities

- One instrument host running Windows 10 (section half gantry) had to be replaced with a Windows 7 computer. Other instrument hosts and workstations running the recently deployed Windows 10 or macOS Sierra operating systems are functional with a few minor incidents that were resolved.
- All members of the science party received instructions and training pertaining to network and Exchange email access. The scientists' personal computers were connected to the ship's wireless network.

HSE Activities

- The first fire and lifeboat safety drill was held on 30 July.
- We conducted HF safety classes with pertinent scientists and technicians as well as Siem Offshore first responders. The HF hood and surrounding areas were prepared for operations.
- All personnel checked their local safety equipment.