IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 3 Report (6–12 August 2017)

Operations

Week 3 began with the final 245 nmi of the 286 nmi transit to Site U1507 (proposed Site NCTN-8A). We arrived at 2200 h on 6 August. After lowering the thrusters and switching to dynamic positioning (DP) mode, the rig floor was cleared for operations, beginning Hole U1507A at 2225 h. The rig crew assembled an advanced piston corer (APC)/extended core barrel (XCB) bottom-hole assembly (BHA) by 0130 h on 7 August, picked up drill pipe and the top drive, and deployed the bit just above the seafloor. A wiper "pig" was pumped through the drill string to clean out potential debris. The nonmagnetic APC core barrels were dressed with core liners in preparation to spudding Hole U1507A at 1040 h.

The mudline core recovered 6.2 m, establishing the water depth at 3568 m. APC coring continued to Core 26H. Given the force required to retrieve the last few APC cores, and the overdrilling required on Core 26H, we switched to XCB coring at 1815 h on 8 August. Given depth objectives for Site U1507 (>700 m), we decided against using the more time consuming half-length APC coring system. Recovery of Cores 1H through 26H ranged from 99% to 106% and averaged 104% (total of 243.7 m cored and 252.7 m recovered). Temperature measurements were taken with Cores 4H, 7H, 10H, 13H, 16H, and 19H. Deployment of orientation and temperature tools was discontinued after Core 20H.

Coring continued in Hole U1507A with the XCB system. Towards the end of 9 August, and at ~425 m DSF, it took ~100–150 min to cut a core. Moreover, the quality of the cores was poor, with prominent "biscuiting" and abundant fracturing. At midnight we decided to terminate Hole U1507A, pull the drill string, and start a rotary core barrel (RCB) hole at the depth where XCB coring became especially problematic (~375 m DSF). Recovery for the XCB cores varied from 6% to 97% and averaged 55% (total of 181.7 m cored and 100.1 m recovered). The drill string was retrieved from Hole U1507A and cleared the rig floor at 0940 h on 10 August, ending Hole U1507A. The time spent on Hole U1507A was 83.25 h or 3.5 d.

The ship was offset 20 m to the east of Hole U1507A. An RCB BHA was made up with a center bit installed in the core barrel that would allow us to drill without coring for the first 375 m. We included a mechanical bit release (MBR) that would allow us to drop the bit at the bottom of the hole then wireline log without retrieving the entire drill string. Drill pipe was deployed and by 1800 h on 10 August the bit was just above the seafloor. After picking up the top drive we pulled the core barrel with center bit and pumped a wiper "pig" through the drill string to clean out debris observed during drill string assembly. The core barrel with center bit was then dropped back in place and drilling in Hole U1507B began at 2045 h on 10 August. Drilling without

coring in Hole U1507B reached 376 m DSF by 0630 h on 11 August. The center bit was removed from the core barrel and coring began at 0730 h.

At midnight on 12 August, the end of week 3, Cores U1507B-2R through 19R had penetrated from 376 to 548.4 m DSF. Recovery for these RCB cores varied between 10% and 105% and averaged 74%. Importantly, the quality of RCB cores was superior to those collected by XCB drilling over the 50 m overlap interval.

Science Results

During week 3, the scientists continued to examine cores and samples from Hole U1506A. On 8 August the laboratory teams began sampling and analysis of cores from Hole U1507A and nearly completed that work by the end of the week. On 12 August, initial measurements and observations began on cores from Hole U1507B.

Site U1506

The lithostratigraphy of Hole U1506A was divided into lithostratigraphic Unit I consisting of nannofossil ooze and chalk, and Unit II consisting of volcanic rock. Subunit Ia (0–258.2 m CSF-A) is ~258 m thick and consists of Pleistocene to Miocene nannofossil ooze with foraminifers. Subunit Ib (258.2–264.4 m CSF-A) is ~6 m thick and consists of Oligocene nannofossil chalk with foraminifers. Subunit Ic (264.29–264.63 m CSF-A) is 34 cm thick and consists of Eocene glauconitic nannofossil chalk with foraminifers. Unit II (264.63–305.3 m CSF-A) is ~41 m thick and consists of microcrystalline to fine-grained basalt. This unit can be further divided into intervals of highly vesicular and amygdaloidal basalt, and intervals of massive basalt. Thin sections and X-ray diffraction (XRD) measurements showed that the basalt is dominated by Ca-plagioclase and clinopyroxene, alongside various alteration minerals such as Fe-Ti oxides and chlorite.

A palynological reconnaissance study carried out on four samples from Hole U15076A (core catcher samples from Cores 24R, 26R, and 28R, and one additional sample from the middle Eocene glauconite-rich layer in Section 29R-2) were found to be barren of palynomorphs.

The geochemistry team finished solid phase analyses on samples from Hole U1506A. Carbonate ($CaCO_3$) content is >88 wt% throughout lithostratigraphic Unit I and increases with depth, with the highest values (~95%) between 85 and 143 m, and between 200 and 228 m CSF-A. Total organic carbon (TOC) content is accordingly low, with values ranging between 0.2 and 0.4 wt% in the top ~210 m CSF-A, and with slightly higher values of 0.6–1 wt% from 219 to 247 m CSF-A. Trace amounts of nitrogen are present in the uppermost two samples (0.65 and 14.32 m CSF-A).

Site U1507

The main lithology encountered in Hole U1507A was nannofossil ooze, which transitions to nannofossil chalk in Core U1507A-32X (~300 m CSF-A). Several centimeter-thick greenish gray layers, rich in clay, volcanic ash, and silicate minerals, are intercalated in this lithology starting with Core U1507A-7H (~60 m CSF-A) and continuing to the bottom of the hole. These layers, along with some of the nannofossil ooze and chalk, appear to represent cyclic background sedimentation. A significant portion of the nannofossil ooze and chalk contained soft-sediment deformation structures, such as slump folds, tilted bedding, load casts, and cm-scale faults, as well as graded beds and other sedimentary structures indicative of mass flow deposition. A ~100 cm thick layer of dark, poorly sorted, polymictic conglomerate with well-rounded grains up to pebble size, was encountered at 291.5 m CSF-A. Thin sections confirmed its mainly volcaniclastic composition. Intense drilling disturbances occurred in the lower part of the hole cored using the XCB (244–416 m CSF-A).

Cores U1507B-2R through 14R (376–499 m CSF-A) consist of clayey nannofossil chalk, with a few ~1–5 cm layers of foraminiferal limestone and greenish-gray nannofossil claystone with volcanic ash. Soft-sediment deformation structures such as slump folds, tilted bedding, and centimeter-scale faults abound.

Nannofossil and planktic foraminifera biostratigraphy place Cores U1507A-1X through 19X in the Pliocene-Pleistocene, and Cores 20X to 46X in the Miocene. Cores U1507B-2R to 7R are early Miocene in age, and Cores 8R to 16R are late Oligocene in age. Rare to common, well-preserved radiolarians are found in Cores U1507A-1H to 6H and Cores U1507B-7R and 9R. Benthic foraminifera generally indicate a lower bathyal paleodepth, and in some intervals (e.g., Core U1507A-22H) their assemblages contain a mixture of deep and shallower taxa with different preservation states. Ostracods are rare to common in Cores 1H to 30X.

A palynological reconnaissance study was carried out on four samples from Hole U1507A (core catcher samples from Cores 7H, 22H, 32X, and 42X). Only the sample from Core 7H yielded trace amounts of organic-walled dinocysts, which corroborate the age determined by the other fossil groups and indicate an open ocean setting.

Section halves from Core U1507A-1H have a stable normal polarity. Paleomagnetic directional data from Cores 2H through 46X are noisy, which makes a magnetostratigraphic interpretation difficult. This may be due to numerous turbidite layers as well as drilling disturbance in the intervals collected with the XCB. However, in contrast, paleomagnetic measurements of archive section halves as well as 70 discrete sample from Cores U1507B-4R to 14R yield a very stable signal and clear series of paleomagnetic reversals that can be correlated to the geomagnetic polarity timescale (GPTS). Anisotropy of magnetic susceptibility (AMS) was measured on 70 discrete samples. Most samples, selected from undisturbed intervals in the core sections, show oblate magnetic fabric, with the minimum axis of the AMS ellipsoid statistically oriented perpendicular to the bedding, as expected in sedimentary rocks.

Gamma ray attenuation (GRA) bulk density at Site U1507 increases from ~1.64 to ~2.1 g/cm^3 and porosity gradually decreases from ~72% to ~40% in the upper ~420 m CSF-A at Hole U1507A. This is 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. Intermittently higher *P*-wave velocity values of ~2200 m/s and even as high as 2500 m/s were measured in discrete layers at ~390 m CSF-A and deeper in both Holes U1507A and U1507B. Thermal conductivity data show a gradually increasing trend with depth from 1.1 to 1.6 W/m·K over the top ~450 m CSF-A. Magnetic susceptibility (MS) is generally low around 5 IU, natural gamma radiation (NGR) values are around 2–3 counts/s, and the color reflectance (L*, a*, and b*) are ~75, 2, and –4, respectively, from 0 to ~270 m CSF-A. Below ~270 m CSF-A, all of the parameters start to vary appreciably downhole. In particular, MS and NGR increase downhole from ~380 m CSF-A to the bottom of the interval cored thus far.

In situ temperature was measured for Cores U1507A-4H, 7H, 10H, 13H, 16H, and 19H. In conjunction with thermal conductivity measured on the cores, we used the Bullard method and found that the temperatures were close to a conductive state. We were able to get a good estimate of the heat flux, a value in line with the tectonics of the region.

A total of 56 interstitial water (IW) samples were collected from Cores U1507A-1H to 45X and Cores U1507B-6R to 14R. The results show a distinctive difference between the upper 250 m CSF-A and those below 250 m, corresponding to the change from APC to XCB coring. The IW constituent profiles in the upper 250 m are smooth, whereas the profiles are more scattered below 250 m. Despite such distinctions, Mg, K, and SO_4^{2-} generally decrease while Ca increases downhole. Dissolved Sr increases smoothly in the upper 160 m and then remains roughly at a constant value. The negative correlation between Ca and Mg may suggest siliceous alteration reactions at the basement. The downhole decrease in SO_4^{2-} suggests sulfate reduction of particulate organic carbon, which also explains the rise in dissolved NH_4^+.

Headspace gas samples were routinely collected from each core in Holes U1507A and U1507B. Hydrocarbon concentrations in all samples were below detection limit.

Education and Outreach

The Education and Outreach Officers ran two successful “Ship to Shore” video links for education institutes this week. They were interviewed by a media group, Press4kids(US), a children’s newspaper, and scheduled two radio interviews for researchers. They confirmed link up contacts with schools and community groups for week 4 and ran Zoom link tests.

They prepared conferences with scientists for the week’s events and continued to promote the *JOIDES Resolution* “Ship to Shore” links to education outlets in the USA, Australia, and New Zealand, and continued posts on social media sites.

The videographer collected images and videos for social media and television media outlets, logged the image and video files, scheduled interviews, and assisted in educational activities. He made two videos covering the scientists as they left port as well as a drone video of the *JOIDES Resolution*.

Technical Support and HSE Activities

Underway Activities

- Magnetic and bathymetric data were collected on the transit from Site U1506 to Site U1507.
- The GI seismic source was prepared and rigged for the upcoming vertical seismic profile (VSP) experiment.
- The ship's mechanic finished the repairs on the magnetometer winch. The winch now comes to a complete halt when the operator releases the hydraulic motor control.
- New high-pressure airline leads were fabricated for both the GI and G gun clusters.

Laboratory Activities

- HF sample preparation for palynology was safely implemented.
- An issue with the Whole-Round Multisensor Logger code, whereby data from two sections would merge in certain situations, was fixed.

Application Support Activities

- A new DESClogik version (16.1.0.16) was deployed that improves the "not saving cached template" issue, but does not completely solve it. A problem occurs when a new version of a template is deployed with DESClogik already open.
- A bug that prevented DESClogik from uploading tests for smear slide samples was fixed.
- Progress was made with the LDAQ Coulometer project.
- A bug was fixed that had caused incorrect depth reporting in LORE for the handheld X-ray fluorescence data.

IT Support Activities

- Continued to fix small issues with new workstations and Windows 10 deployed during the Subic Bay tie-up period. Overall, the new Windows 10 and macOS Sierra systems are performing well.
- TAMU IT restored a function within Outlook Web Access to allow users to set a signature for outgoing messages.

- A fix for the problem whereby a Windows 10 computer would run out of memory has been tested and deployed to all of the new Windows 10 machines on the ship. The issue was related to an incompatible hardware driver.
- The surplus Windows 7 computers are being prepared for shipping to shore.
- Two Mac Pros were deployed to the Imaging Office.

HSE Activities

- The second fire and lifeboat safety drill was held on 6 August.
- Conducted the last HF safety class with the Siem Offshore first responders (night shift).
- Staff completed routine checks of laboratory safety systems.