IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 4 Report (13–19 August 2017)

Operations

Week 4 began while cutting Core U1507B-20R (548.4–558 m DSF). Rotary core barrel (RCB) coring continued to Core 53R with a total depth of 864.4 m DSF and concluded at 1000 h on 17 August. Hole U1507B was drilled without coring from 0–376 m DSF, then RCB coring penetrated from 376 to 864.4 m DSF and recovered 371.5 m (76%). Mud sweeps were pumped for hole cleaning on every third core starting with Core 8R. At the end of coring, Hole U1507B was cleaned with a 25-barrel high viscosity mud sweep.

Preparations for wireline logging began with a wireline trip for the rotary shifting tool (RST) to activate the mechanical bit release (MBR) and drop the coring bit at the bottom of the hole. The bit was released at 1130 h on 17 August. The RST was recovered and a second wireline trip was conducted with the Reverse RST to reposition the MBR sleeve into the circulating position. At 1230–1315 h the hole was displaced with 245 barrels of 11.0 ppg mud. The top drive was set back, the end of the drill pipe was raised up to a logging depth of 75.2 m DSF, and the rig floor was prepared for logging.

Assembly of the modified triple combo logging tool string began at 1700 h. The tool string included magnetic susceptibility, electrical resistivity, sonic, bulk density, and natural gamma radiation tools. The neutron porosity tool often run in the triple combo, and the microresistivity imaging (FMS) tool often run in a separate string together with the sonic tool, were omitted from the logging plan for this hole. The tools were assembled and tested at 1815 h and the tool string was lowered into Hole U1507B.

The wireline active heave compensator was switched on once the tools reached open hole. A downhole log was performed from just above seafloor to the bottom of the hole at ~864 m WSF. The hole was then logged up for a 124 m calibration pass, run back to bottom, and logged up to just below the end of pipe where the caliper was closed prior to entering the bottom-hole assembly. The tools were pulled from the hole and were back at the surface at 0200 h on 18 August. By 0345 h all logging equipment was rigged down and the rig crew began retrieving the drill string.

Hole conditions were excellent for logging, with a hole diameter close to the bit diameter (~10 inch) all the way from the bottom of the hole (846.4 m WSF) to ~490 m WSF. Hole conditions were still good up to 234 m WSF, where a bridge with hole diameter of only ~6 inch was encountered. Additional bridges were indicated in the caliper log further uphole and just below the base of the drill string. The tool string passed these obstructions successfully and acquired high quality measurements throughout the open hole. However, several hours of remediation

work (washing) would have been required before the Versatile Seismic Imager (VSI) tool could have been run as planned, with limited chance of success, significant daylight time restrictions, and poor weather forecast. Given the quality of the standard logs, particularly the sonic log, the primary logging scientific objective of tying cores to seismic-reflection images had been substantially achieved, so we cancelled the VSI run.

While the drill string was recovered, the seafloor positioning beacon was released and recovered. With bad weather expected on the transit to the next site, the drill collars were disassembled and secured in the drill collar rack. At 1130 h on 18 August, the end of the drill pipe cleared the rig floor. The rig floor was secured for transit at 1150 h, ending Hole U1507B and Site U1507. A total of 194 h or 8.1 d were spent at Hole U1507B.

While raising the thrusters, a hydraulic malfunction occurred and was repaired, and the transit to Site U1508 (proposed Site REIS-1A) began at 1330 h on 18 August. On 19 August, the ship speed and course were adjusted to accommodate rough weather. At the end of week 4 we have traveled 291 nmi and expect to arrive at Site U1508 (proposed Site REIS-2A) at 2200 h on 20 August.

Science Results

During week 4, the scientists completed measurements and observations on the lower part of Hole U1507B (Cores ~15R to 53R, ~500 to 855.7 m CSF-A), revised Site U1506 reports, and began writing Site U1507 reports.

The sediment section between 500.4 and 542.9 m CSF-A is part of lithostratigraphic Subunit Ib (401.19–542.9 m CSF-A), and consists of upper Oligocene, greenish gray clayey nannofossil chalk with volcanic ash interbedded with dark grey clayey tuffaceous sandstone and greenish gray clayey foraminiferal limestone.

Subunit Ic (542.9–685.5 m CSF-A) is ~143 m of lower Oligocene to upper Eocene dark greenish gray, coarser grained tuffaceous conglomerate and sandstone alternating with light greenish gray clayey nannofossil chalk with volcanic ash. This interval is marked by an increase in magnetic susceptibility and natural gamma radiation (NGR) values and by the first occurrence of a thick-bedded tuffaceous conglomerate in Core 1507B-19R.

Lithostratigraphic Unit II (685.5–855.7 m CSF-A) is ~170 m of upper Eocene to middle Eocene homogeneous light greenish gray bioturbated clayey nannofossil chalk, with common burrows. Within Cores 50R and 51R (~830 m CSF-A), the lithology changes to a greenish grey nannofossil claystone, possibly reflecting carbonate dissolution that occurred during the Middle Eocene Climatic Optimum (MECO, below).

Nannofossil and planktic foraminifera biostratigraphy places Cores 17R to 29R (523–639 m CSF-A) in the early Oligocene. The Eocene–Oligocene boundary is between Cores 29R and 30R (639–642 m CSF-A) because the top of benthic foraminifera *N. truempyi* is recorded in 30R-CC. Nannofossil and planktic foraminifera indicate late to middle Eocene ages for Cores 30R to 53R (642–856 m CSF-A, corresponding to lithostratigraphic Subunit Ic and Unit II). The upper MECO and post-MECO strata were recovered in Core 50R. Most of Core 51R, which was expected to contain the rest of the MECO strata, was lost during drilling operations.

Radiolaria are rare to common in Cores 29R to 53R (639–856 m CSF-A) and poorly to moderately preserved. Cores 31R to 53R (654–856 m CSF-A) correspond to Zones RP19 to RP14; however, many low-latitude index species are absent or rare and sporadic in occurrence. Benthic foraminifera are rare throughout the core. Preservation is often poor and some tests are infilled with pyrite. Assemblages indicate a lower bathyal depth of deposition. Ostracods are absent in Hole U1507B, except for sample 31R-4W, 23–25 cm, where one carapace specimen was found.

Samples for palynological analysis taken from Hole U1507B await processing.

Pass-through paleomagnetic data from lithostratigraphic Subunit Ib and Subunit Ic as well as results from principal component analysis of alternating field demagnetization data of 59 discrete samples from these intervals, yield a well-defined series of paleomagnetic reversals that can be correlated to the geomagnetic polarity timescale between the early Miocene and late Eocene. However, paleomagnetic data from Unit II are noisy with weak remanence, which makes magnetostratigraphic interpretation difficult. Anisotropy of magnetic susceptibility (AMS) was measured on discrete samples from Subunit Ib and Subunit Ic. 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.

Density values gradually increase from ~2.0 g/cm^3 at 600 m CSF-A to 2.3 g/cm^3 at 640 m CSF-A, returning to 2.0 g/cm^3 at the base of the hole (856 m CSF-A). Porosity values gradually decrease with depth from ~40% at 600 m CSF-A to ~30% at ~850 m CSF-A, showing a normal compaction trend for carbonates. Thermal conductivity data show a gradual increasing trend with depth from ~1.5 W/m·K (593 m CSF-A) to ~1.75 W/m·K (700 m CSF-A), then remain constant to the base of the hole. Magnetic susceptibility (MS) data show high values between 600 and 680 m CSF-A with local spikes up to 1000 instrument units (IU). Below 680 m CSF-A, values decrease to ~40 IU and are constant in the lowermost part of the hole. *P*-wave sonic velocities are generally around 2500 m/s from 600 m CSF-A to the base of the hole, except at 640 and 725 m CSF-A where values increased to 3000 and 2500 m/s respectively, in 10 m thick intervals of clayey nannofossil chalk in Unit I. The natural gamma radiation (NGR) profile shows a gradual decrease from ~40 cps at 600 m CSF-A to ~5 cps at ~680 m CSF-A, then remains constant to the base of the hole.

Wireline logging data acquired in Hole U1507B are of good to excellent quality and await analysis and integration with core data. Caliper data show a smooth hole diameter only ~1 inch larger than bit size in the lower part of the hole (485 to 825 m WSF) and ~2 inch larger than bit size above that interval. Gamma radiation increases in two intervals, 420 m to 540 m WSF and 580 m to 690 m WSF, closely matching the variations from core measurements. Bulk density increases systematically downhole from 1.7 g/cm^3 at 100 m WSF to ~2.0 g/cm^3 at 440 m WSF, decreases in the interval 450 to 500 m WSF, then remains constant at ~2.2 g/cm^3 from ~500 m to the bottom of the hole. The wireline bulk density closely matches the bulk densities measured on cores using the MAD method. The resistivity profile mirrors the natural gamma ray signal. Sonic shear wave and compressional wave velocities are strongly correlated. In the top 400 m WSF, corresponding to lithostratigraphic Subunits Ia and Ib, *P*-wave velocity generally increases from 1650 m/s to about 2500 m/s, values that are several hundred meters per second higher than those from core measurement. Overall comparison with core measurements indicates a strong rebound effect on sonic velocities in Subunits Ia and Ib, but not in Subunits 1c and Unit II. The ability to link the logs to the site survey data is promising.

Solid sediment analysis on samples from Hole U1507B was completed at a sampling resolution of at least one sample per core. Carbonate content is generally high in the nannofossil ooze and chalk lithologies of lithostratigraphic Units I and II, typically between 50% and 75%. Somewhat lower carbonate content throughout Subunits Ib and Ic correlates well with changes in other properties, such as color, MS, and NGR. Intercalated darker layers are represented by lower total carbon and carbonate (~20%) content, without any correlation to TOC content. Headspace gas samples were routinely collected from each core in Holes U1507B. Hydrocarbon concentrations in all samples were below detection limit.

Interstitial water (IW) profiles from Site U1507 exhibit chemical similarities to those at DSDP Site 590 on the Lord Howe Rise, ODP Site 806 on the Ontong Java Plateau, DSDP Site 323 in the southeast Pacific, and Site 239 in the southwest Indian Ocean. At all five of these sites, dissolved Ca concentrations increase while Mg and K decrease with depth, and Sr concentrations increase to a plateau but are relatively constant deeper in the sediment. Moreover, sulfate concentrations decrease somewhat with depth at these sites. Changes in the major and minor element concentrations of IW samples may involve reactions with basaltic basement rock underneath the sediment column, with dispersed volcanic material in the sediment column, or both. The drop in K may be the result of ion exchange with clay minerals or formation of K-feldspar in the sediment.

Education and Outreach

“Ship to Shore” video outreach events with education institutes and community groups this week included four presentations to Barker College in New South Wales, Australia; a presentation to the Geological Society in Cornwall, England; and a show for Kelvin Grove State High School in

Brisbane, Australia, as a lunch time attraction during their science fair. Various science party members supported and participated in the events.

Preparations were carried out for upcoming events, including scheduling of interviews with Spanish and Columbian radio stations, Kenmore State School in Brisbane, Chanel College in Gladstone, Emmaus College in Rockhampton, Queensland, and an open day at Geoscience Australia.

Education and Outreach personnel continue to promote *JOIDES Resolution* Ship-to-Shore outreach events with education outlets in the USA, Australia, and New Zealand, write blogs, and post on social media sites.

A video covering the first drill site and a brief history of Zealandia was uploaded. Images and videos are being collected for use by social media and television media outlets. Interviews with the Co-Chief Scientists, other science party members, and drill crew members were recorded, to be used in shipboard video projects and after the expedition.

Technical Support and HSE Activities

Underway Activities

- In the process of setting up for the vertical seismic profile (VSP) experiment in Hole U1507B, which was ultimately canceled for operational and science reasons, we found a number of issues with the high pressure regulator and manifold on the port side of the ship. This included problems with the control knobs on the load and bleed valves and regulator control problems. We cleared debris in the load and bleed valves, removed the starboard side regulator and manifold, and installed it on the port side.
- Magnetic and bathymetric data were collected on the transit from Site U1507 to Site U1508. Because of high sea conditions, the magnetometer was retrieved after the first day at the Captain's request.

Laboratory Activities

- A band-pass filter issue in the *P*-wave velocity software, which caused a DC offset in the data, was fixed.

Application Support Activities

- Completed work on the data uploader program for the handheld XRF scanner.
- Completed coding on the LDAQ Coulometer project and began testing and debugging.

IT Support Activities

- Obsolete computer equipment to be shipped to shore, including computers, printers, and monitors, has been packed and inventoried.
- On 14 August, the aft communications satellite antenna stopped transmitting. The problem was identified to be a defunct signal amplifier, which was replaced on 17 August. Sporadic Internet outages occurred during the period of troubleshooting and repair, when only the bow satellite antenna was functional.
- An error message on the Uninterruptable Power System (UPS) supporting the Datacenter has been cleared with the help of Siem Offshore's Chief Electrician. The UPS is working as normal.

HSE Activities

- A fire and lifeboat safety drill was held on 13 August.
- Staff completed routine checks of laboratory safety systems.