

IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 5 Report (20–26 August 2017)

Operations

Week 5 began while in transit to Site U1508 (proposed site REIS-2A). We completed the 546 nmi transit at an average speed of 9.5 kt and arrived at Site U1508 at 2300 h on 20 August. Thrusters and hydrophones were lowered for dynamic positioning and the rig floor was cleared for operations at 2342 h. At 0130 h on 21 August we deployed an acoustic beacon for hole positioning. An advanced piston corer (APC)/extended core barrel (XCB) bottom-hole assembly (BHA) was made up and the drill string was assembled and deployed to just above the seafloor. The top drive was installed, and the nonmagnetic core barrels dressed with core liners and the orientation tool were deployed. APC coring in Hole U1508A started at 0900 h on 21 August 2017.

After shooting Core U1508A-10H at 1520 h, the core line parted just above the sinker bar. The wireline was cut and a new rope socket was installed. An RCB core barrel was dressed with a fishing shoe, and by 1800 h on 21 August the sinker bars and core barrel with Core 10H had been recovered in two wireline trips.

Use of the core orientation tool was postponed until we cut Core 13H because of sandy hole conditions, and it was discontinued after Core 17H because of unstable hole conditions. Temperature measurements were taken on Cores 7H, 9H, 10H, 12H, 14H, and 17H.

Core 23H had to be drilled over for 40 min to release it from the formation. At 0600 h on 22 August we started to retrieve the drill string and the bit cleared the rig floor at 1140 h, ending Hole U1508A. Total recovery for the 210.3 m cored in Hole U1508A was 201.13 m (96%). The time spent on Hole U1508A was 36.0 h or 1.5 d.

The ship was offset by ~20 m to the southwest. An RCB BHA was made up and deployed, and the drill pipe was assembled until the bit was just above the seafloor. The top drive was picked up and drilling without coring in Hole U1508B started at 1745 h on 22 August, with a center bit installed in the core barrel. At ~75 m DSF, the drill string became stuck while making a connection. After pumping a mud sweep we were able to free the drill string. A total of 85 barrels of mud were pumped for the next ~100 m of drilling. Drilling ahead without coring reached the target (186.6 m DSF) at 2245 h on 22 August, the center bit was retrieved, and an RCB core barrel was dropped to begin coring with Core U1508B-2R. After achieving low recovery on Cores 23R to 25R, and reaching a zone of particular science interest at ~417 m DSF, we decided to cut half cores for Cores 26R through 33R. When recovery began to improve, we switched back to full-length cores with Core 34R.

RCB coring continued to Core U1508B-38R (503.4 m DSF), when at 0700 h on 24 August a medical emergency was declared and drill string recovery began. Cores U1508B-2R through 38R penetrated from 186.6 to 503.4 m DSF and recovered 133.32 m (42%). Mud sweeps were pumped for hole cleaning on every third core starting with Core 5R. Core recovery varied from 3% to 104% throughout Hole U1508B.

The acoustic beacon was released and recovered, the drill string was retrieved and set back in the derrick, and the rig floor was secured, ending Hole U1508B at 1320 h on 24 August. Time spent on Hole U1508B was 49.5 h or 2.1 d.

After securing the rig floor for transit, the hydrophones and thrusters were raised and the 302 nmi transit to Auckland began at 1354 h on 24 August. The clocks were advanced 1 h for the first time at 1400 h, and a second time at 0200 h on 25 August. We arrived at the dock in Auckland at 2106 h on 25 August. The medical evacuee, accompanied by two doctors and the port agent, and a crew member disembarked. The ship left Auckland at 0218 h on 26 August to return to Site U1508. At the end of week 5, we had completed 214 nmi of the ~302 nmi transit.

Science Results

During week 5, the scientists completed measurements and observations on cores from Holes U1508A and U1508B, and finalized reports for Site U1507.

Three preliminary lithostratigraphic units were proposed for the composite stratigraphy of Site U1508 (0–496.9 m).

Lithostratigraphic Unit I (0–90.5 m) consists of ~91 m of coarse-grained bioclastic sand that contains abundant bryozoans, alternating with foraminiferal ooze with nannofossils. The base of the unit is marked by a sharp transition from foraminiferal ooze to clayey nannofossil ooze with biosilica.

Lithostratigraphic Unit II (90.5–379.3 m) is ~290 m of nannofossil ooze with varying amounts of foraminifers, clay, and sponge spicules. The unit is further divided into two subunits. Subunit IIa (90.5–254.3 m) is ~165 m of homogeneous nannofossil ooze with foraminifers. Subunit IIb (254.3–379.3 m) is ~125 m of foraminiferal ooze/chalk, with rare to occasionally abundant glauconite, interbedded at the decimeter scale with nannofossil ooze and chalk. The Subunit IIa/IIb boundary is defined by a darkening of the sediment and an increase in clay content, accompanied by a ~20% decrease in CaCO₃ content.

Lithostratigraphic Unit III (379.3–496.9 m) is ~120 m of bioturbated nannofossil chalk with sporadic centimeter-scale layers of cherty limestone. The unit is defined by an abrupt decrease in grain size from sand-sized foraminifers dominating the lithology of Subunit IIb to nannofossil chalk.

Nannofossil and planktic foraminifera biostratigraphy identified Pleistocene–Pliocene (1.3–95.8 m) and Miocene (106.0–210.2 m) in Hole U1508A, and Miocene to Oligocene (191.4–373.3 m) and late to middle Eocene (382.2–497.0 m) in Hole U1508B. Nannofossil Zones NN3 and NN2 (~15–18 Ma) were not observed, and despite the incomplete recovery between Zones NN4 and NN1, a hiatus or condensed interval may exist at ~312 to 324 m.

Radiolarians are well preserved and common to abundant in the lower half of Hole U1508A (95.7–210.2 m). Few to abundant and well-preserved radiolarian assemblages of Miocene age are present in samples at 191.4 to 210.6 m. The interval from 382.2 to 462.2 m contains rare to few, moderately preserved late Eocene radiolarian assemblages, and the interval below (474.3–484.6 m) contains a middle Eocene assemblage.

Benthic foraminifera are present in most of the studied samples, and their preservation ranges from excellent to moderate in Hole U1508A, to mostly poor in Hole U1508B. They indicate a lower bathyal depth of deposition, and reworked taxa are very common in Hole U1508B, where foraminiferal tests display a wide range of preservation states. Ostracods are abundant with preservation ranging from moderate in Hole U1508A to poor in Hole U1508B. A mixture of neritic to bathyal taxa are present in multiple intervals in Hole U1508B.

Palynology samples from Hole U1507B ($n = 6$) were barren of palynomorphs, except for the sample from ~855 m, which contained trace amounts of dinocysts that are consistent with a middle Eocene age inferred from nannofossil and planktic foraminifera biostratigraphy. All samples from Holes U1508A ($n = 3$) and U1508B ($n = 2$) contain well-preserved palynomorphs. The Miocene–Oligocene material contains a rich palynological assemblage, characterized by inner to outer neritic dinocysts, gymnosperm pollen, and fern spores.

Pass-through paleomagnetic data from most intervals at Site U1508 are noisy, including the foraminiferal ooze (Unit I), nannofossil ooze (Subunit IIa), part of the silicate mineral-rich foraminiferal chalk (Subunit IIb), and the clayey nannofossil chalk (Unit III). No reliable magnetostratigraphic result can be obtained from these intervals. However, part of Subunit IIb (~255–380 m) has a higher natural remanent magnetization intensity compared to other intervals, which yields a stable paleomagnetic signal. Although core recovery in this interval is generally low, making magnetostratigraphic correlation difficult, some well-defined paleomagnetic reversals enable a reliable correlation to the geomagnetic polarity timescale for the early Miocene to late Oligocene. Results from principal component analysis of alternating field demagnetization data of discrete samples confirm the reliability of pass-through paleomagnetic data.

Anisotropy of magnetic susceptibility (AMS) was measured on discrete samples from all three lithological units. AMS data for samples from Hole U1508A are noisy, which is probably due to sample disturbance by pushing cubes into soft sediments. Most samples from Hole U1508B were cubes cut from hard sediments. These cube samples show well-defined oblate magnetic fabric, with the minimum axis of the AMS ellipsoid statistically oriented perpendicular to the bedding.

Bulk density, grain density, porosity, and *P*-wave velocities define layers of differing physical properties, the boundaries of which can be associated with reflections on multichannel seismic data. Velocities and densities of 1600–1700 m/s and 1.5 to 1.6 g/cm³, respectively, occur in the top 200 m (Units I and Subunit IIa) where gradients in physical properties with depth are low. A 100 m/s decrease in *P*-wave speed occurs within this zone at ~90 m. From ~200 m to the base of Hole U1508B (Subunit IIb and Unit III), *P*-wave velocity generally increases from 1600 m/s to 2200 m/s, and bulk density increases from 1.6 to 1.9 g/cm³.

Magnetic susceptibility (MS) and natural gamma radiation (NGR) data reveal variation within the sedimentary sequence. High MS values are observed in Subunit IIb (200–380 m), whereas the remainder of the section has low values. The high values are linked to higher concentrations of silicate minerals. NGR is low in Unit I, shows an abrupt increase at the start of Unit IIa, and then decreases to the base of Hole U1508B (500 m). A local increase is observed from ~320 to ~340 m.

Headspace gas samples were routinely collected from each core in Holes U1508A and U1508B. Methane was detected at concentrations below 100 ppmv in samples from ~460 to ~494 m.

A total of 65 interstitial water samples were collected from Site U1508 by three different methods: whole-round squeezing, rhizon sampling, and half-round squeezing. The latter were ~15 cm intervals taken from core working halves 1–2 d after recovery and crushed in plastic bags. These half-round samples yield reasonable results for some dissolved species, notably sulfate, but not for others. Rhizon results generally lie close to those from squeezed samples, but no clear trends are shown except for strontium and silicon. The manganese concentration profile suggests the true mudline is missing. Adjacent samples from the upper ~100 m of section show large variance because the sediment is loose foraminiferal sand, which makes collection of uncontaminated pore water difficult. Nonetheless, most constituents barely vary in concentration over the uppermost 275 m. Below 275 m, sulfate concentrations decrease downhole and concentrations of ammonium, barium, and strontium increase. The observations suggest a boundary just below 275 m that separates distinct fluid regimes.

Bulk sediment carbonate analysis was completed for Hole U1508A. Carbonate contents are higher than 70%, with the highest values in the upper 90 m of the hole. TOC contents are 0.4% to 0.9%.

Education and Outreach

“Ship to Shore” video outreach events were held with the Geoscience Australia open-day in Canberra (Australia), Kenmore State school (three presentations), Emmaus Anglican School in Rockhampton, and Chanel College in Gladstone (all three in Queensland, Australia), and the

Brooklyn Public library (USA). A live video interview was held with the Spanish radio station El Pais. Several science party members and technical personnel participated in the events.

Preparations were carried out for upcoming events, including a test with the Lycee Jean d'Alembert (Chile, to be conducted in French), Kenmore State School in Brisbane (Australia), Pymble Ladies' College, New South Wales (Australia), and Tamalpais High School and Cerritos College, both in Los Angeles (USA).

Video interviews were held with scientists, IODP staff, and Siem Offshore crew members. These interviews will be used in video uploads during the expedition as well as for postexpedition production.

Technical Support and HSE Activities

Underway Activities

- A GD31 high-pressure regulator used for the seismic sources was rebuilt. A Swagelok engineer was contacted for a replacement model to the Circle Seal GD31 regulator.

Laboratory Activities

- The X-ray technician is developing a macro to study the handheld X-ray fluorescence (XRF) spectral data quality as a function of the instrument's operating parameters such as temperature and vacuum pressure.
- We are in contact with Olympus technical services in regard to issues with the handheld XRF's data files.
- The development of a cookbook for the new ICP-AOS is in progress.

Application Support Activities

- Chemistry technicians are testing the LDAQ Coulometer program on a time available basis.
- The XRF uploader code was modified to handle analysis data greater than 4000 bytes.
- The ImageCapture files contained the wrong sample offsets, which is being addressed.
- The color reflectance white calibration routine for the QEPro spectrophotometer is being updated to recognize and correct integration start times that are too long and result in data clipping and bad calibrations.
- Changes to the Whole-Round Multisensor Logger logic are being tested, including:
 - Identify the start and end of section measurement, which triggers the saving of data, clearing displays, and other instrument specific tasks.

- Handle sections too short to engage a sensor in one push sequence. Prior to the fix, the program would prematurely abort the measurement. The 15 cm minimum section length requirement was eliminated.
- Correctly handle sections where the maximum measurement length is less than the distance from section top to the last instrument position.

IT Support Activities

- The issue of McAfee Antivirus definition repository not updating was resolved.
- Automatic email notifications and alerts were configured on the color printers and copier.
- All hard drives were removed from surplus Windows workstations and prepared for shipping to shore.

HSE Activities

- The weekly fire and lifeboat safety drill was postponed due to inclement weather.
- Staff completed routine checks of laboratory safety systems.