IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Week 7 Report (3–9 September 2017)

Operations

Week 7 began while cutting Core U1509A-4R from 19.4 m. Coring in Hole U1509A continued until 2345 h on 6 September, to a total depth of 690.7 m (Core U1509A-74R). The hole was cleaned with 10–15 barrel mud sweeps, which were pumped on every third core from 9R through 49R. Starting with Core 50R the frequency and volume of mud sweeps were increased to every other core and 20–25 barrels, respectively. Total recovery in Hole U1509A was 462.86 m (67%).

In preparation for logging, Hole U1509A was cleaned with a 30-barrel high viscosity mud sweep. The rotary shifting tool (RTS) was deployed to trigger the mechanical bit release (MBR) and drop the bit at the bottom of the hole (0015 h). The reverse RST was deployed to shift the MBR sleeve back into the circulation position (0145 h). Next, the hole was displaced with 214 barrels of 10.5 ppg mud, the top drive was set back, and the drill string was pulled back to the logging depth of 81 m (0530 h). The modified triple combo logging tool string was rigged up when at 0645 h the operational decision was made to stop logging operations based on ship heave exceeding 3.0 m. The drill string was retrieved and the rig floor secured for transit by 1434 h, ending Hole U1509A and Site U1509. A total of 127.5 h or 5.3 d were spent on Hole U1509A. After recovering the seafloor positioning beacon and retrieving positioning thrusters and hydrophones at 1630 h on 7 September, the ship began the ~200 nmi transit to the north to avoid severe weather that was forecast for 9–10 September at the remaining proposed drilling sites.

At the end of week 7, we were waiting on weather at a position 380 nmi to the north of the next anticipated site.

Science Results

During week 7 the scientists completed measurements and observations on all cores from Hole U1509A, and completed reports for Site U1508. All depths reported in this section are meters CSF-A unless noted otherwise.

The sedimentary sequence at Site U1509 consists of ~415 m thick calcareous ooze, chalk, and limestone (Unit I), overlying ~275 m thick claystone (Unit II).

Lithostratigraphic Unit I is divided into three subunits. Subunit IA (0–99.6 m) consists of calcareous ooze and chalk with rare tuffaceous beds. Rotary core barrel (RCB) coring led to soupy and mousse-like drilling disturbances in the soft sediments of the upper ~50 m of this subunit, followed by biscuiting, horizontal cracking, fracturing, and pulverization in the rest of

the unit where the formation is more lithified. The ooze-to-chalk transition was observed at ~55 m. Subunit IB (99.6–139.28 m) comprises calcareous chalk showing significant soft-sediment deformation (i.e., slumps). Subunit IC (139.28–414.57 m) consists of calcareous chalk and limestone with biosilica and several silicified (chert) intervals. Subunit IC is distinctively characterized by tilted bedding (apparent dip ~20°). From Subunit IC downhole, preferential fracturing of cores was seen along primary deformation structures such as shear zones, microfaults, and tilted bedding. The chalk to limestone transition occurs within Subunit IC around 385 m.

Lithostratigraphic Unit II is divided into two subunits. Subunit IIA (414.57–614.2 m) consists of claystone with nannofossils and silt. Subunit IIB (614.2–689.68 m) consists of massive brown claystone with minor bioturbation and agglutinated benthic foraminifera. Similar to Subunit IC, tilted bedding is observed throughout Unit II.

Nannofossil and planktic foraminifera preservation and abundance generally decrease downhole, with these groups absent below 617.6 m and 536 m, respectively. Radiolaria are abundant and well preserved in the upper 393 m, but are rare and poorly preserved farther downhole. Benthic foraminifera abundance is low, and preservation decreases downhole in the upper 249 m, and remains poor below. Only agglutinated taxa are found in sediments below 617.6 m. Ostracods are common to rare with moderate to poor preservation in the upper 178 m, and are rare to barren below. A palynological reconnaissance study focused on Unit II and recovered rich and well-preserved palynological assemblages.

Nannofossil and foraminifera datums yielded Miocene (22.41–82.47 m), Oligocene (90.13–248.63 m), Eocene (259.98–407.07 m), and Paleocene (418.53–609.27 m) ages for the sequence at Hole U1509A. The interval 617.6 to 689.6 m is barren of age diagnostic nannofossils and planktic foraminifera taxa, but contains Late Cretaceous dinocysts, supported by Late Cretaceous agglutinated benthic foraminifera.

The intensity of natural remanent magnetization of most sediment cores from Hole U1509A is weak, mostly around 10^{-4} A/m. This results in generally noisy paleomagnetic data from the pass-through magnetometer. However, stepwise alternating field (AF) demagnetization of some discrete samples gives reliable paleomagnetic data. Integrating these data with biostratigraphy, the observed magnetic polarities at 110 m to ~260 m are tentatively correlated to chrons C9 through C13 of the geomagnetic polarity timescale (GPTS2012). The claystone interval of Subunit IIB produces higher quality pass-through data compared to intervals above. Cores from Subunit IIB have a normal polarity.

Physical property measurements in Hole U1509A show a gradual increase in bulk density and *P*-wave velocity with depth, except within a layer of limestone between ~390 and 415 m. Above the limestone, in ooze and chalk, *P*-wave velocity and bulk density increase with depth from 1500 to 1900 m/s and from 1.55 to 1.90 g/cm^3, respectively. The transition from ooze to chalk is shallow (~60 m) and correlates with a *P*-wave velocity increase of ~100 m/s. The limestone layer

in Unit IC is a discrete interval where *P*-wave velocity and density increase by ~40% and porosity decreases sharply. *P*-wave velocity, bulk density, and magnetic susceptibility are approximately constant in the Unit II claystone below the limestone. A gradual decrease in porosity with depth is also observed. Natural gamma radiation values show high variance in Unit II (values ranging from 8 to 30 counts) that reflect changes in clay composition and abundance.

A total of 13 interstitial water (IW) samples were collected from Hole U1509A. Profiles of some species show trends similar to those at Site U1508. For example, sulfate concentrations decrease and ammonium concentrations increase downhole, suggesting sulfate reduction of organic matter. After sulfate gets reduced, the product hydrogen sulfide reacts with iron, forming pyrite, which is present in most cores from this hole. Sulfate concentrations become lower than 1.0 mM at ~370 m, where methane starts to rise, indicating a deep sulfate methane transition (SMT). Methane concentrations peak between 600 and 700 m. Below the SMT, dissolved Ba concentrations start to rise exponentially. This likely results from the dissolution of barite ($BaSO_4$) in sulfate depleted pore water.

Bulk sediment chemistry corresponds with lithostratigraphic units. Unit I is characterized by carbonate contents that decrease downhole from ~94% at 20 m to ~65% between 360 and 380 m. Carbonate content varies little in the uppermost 200 m, and by more than 10% in the lower part. Carbonate content drops drastically across the transition from Unit I to II (415 m), to average values of 18% and 0.5% in Subunits IIA and IIB, respectively. Organic carbon contents are ~0.3% in Unit I and Subunit IIA and ~1.0% in upper Cretaceous Subunit IIB.

Education and Outreach

Ship-to-Shore video outreach events were held with:

1. Lycee Jean d'Alembert (Chile);
2. Outreach Officers who will sail on upcoming JOIDES Resolution expeditions (Texas, USA);
3. Three events with Robinson's Secondary High School (Virginia, USA);
4. St. Augustine's School (Victoria, Australia);
5. Cleveland District Primary School (Queensland, Australia); and
6. University of Brasilia (Brasilia, Brazil).

Test connections were conducted for events that will take place in the future.

Preparations are being carried out for more than 18 upcoming events with school groups in Australia, New Zealand, USA, Italy, France, and Colombia.

The Education and Outreach Officers produced a video covering the drilling process which was uploaded to YouTube. They continued to conduct scientist interviews as well as collect more video footage of the Core Laboratory and drill rig floor.

Technical Support and HSE Activities

Underway Activities

- Conducted various maintenance tasks in the Underway Geophysics Laboratory, including repair and replacement of seismic air pressure system, air hoses, electronics, and cables.
- Magnetometer and bathymetric data were not collected during the current transit due to very heavy sea conditions, as requested by the Captain.

Laboratory Activities

- No issues were reported this week.

Application Support Activities

- Continued work on LDAQ application for the Coulometer.
- Deployed DESClogik 16.1.0.18, making "Set Lock Here" option for fixing column positions available to all users.
- Continued debugging failures seen in DESClogik when all data for a hole are being retrieved.
- Deployed MUT 15.2.0.19, which applies fixes to the GC3, NGA and XRF analyses.
- Continued work on XRF summary report project.
- Fixed GRA IMS code to fix core diameter and counts/s data.

IT Support Activities

- The ship has been experiencing daily Internet outages (due to a solar interference during autumnal equinox). Each outage period lasts roughly 20 min. We expect daily outages to end by the middle of next week.
- Wiring in the Underway Geophysics Laboratory was reorganized and the UPS was replaced under regular maintenance.
- Continued to install preventative patches for the Windows 10 computers during pauses in coring and core processing.

HSE Activities

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