IODP Expeditions 367 and 368: South China Sea Rifted Margin

Expedition 367 Week 3 Report (19–25 February 2017)

The third week of the IODP South China Sea Expedition 367 consisted of (a) continued advanced piston corer (APC)/extended core barrel (XCB) coring to a final total depth of 659.2 m in Hole U1499A, (b) a 24 h repair to the drawworks, (c) installation of a reentry funnel and 10.75 inch casing to 651 m in Hole U1499B, and (d) preparations for rotary core barrel (RCB) coring the lowermost sediments and basement in Hole U1499B. All times in this report are in ship local time (UTC + 8 h).

Operations

This week began while we were XCB coring in Hole U1499A. Cores 58X to 67X penetrated from 540.7 to 637.7 m (20.37 m recovered; 21%). For the first eight cores, the bit penetrated very quickly through 77.6 m and recovered only 4.16 m (5%), so we infer these are predominantly unconsolidated sands. Core 66X had slower penetration and 100% recovery in finer-grained formation. However, the penetration rate increased again in Core 67X, indicating that we encountered sands again. The last core on 19 February (Core 68X) also cut very quickly and had almost arrived back on the rig floor (~100 m below the rig floor) when the low clutch diaphragm in the drawworks failed at 2245 h on 19 February; consequently, we could not raise the drill string. We secured the drill string and circulated, rotated, and pumped a mud sweep every hour to keep the drill string from getting stuck while repairing the ruptured diaphragm. After 24.5 h the drawworks had been repaired (at 2315 h on 20 February), and we were finally able to open the drill string and remove Core 68X. We had suspected it would be empty since it cored very quickly through inferred sands, but also it had been sitting in the drill string for a full day. Although coring recovery was quite variable, the finer-grained formation we did recover was getting quite hard. We wanted to penetrate a few more cores to verify an appropriate formation to set the base of the casing to be deployed in our next hole (firm formation, not sands).

Cores 69X–71X then penetrated quite slowly from 647.4 to 659.2 m and recovered 1.8 m of hard sedimentary rock. We decided this was an appropriate interval for the base of the casing. The driller then circulated the entire hole with mud to minimize risks of hole problems as we pulled the drill string out of the hole. We kept the top drive installed until the bit was at 299 m, above the uppermost interval of unconsolidated sands. The bit cleared the seafloor at 1230 h on 21 February and arrived on the rig floor at 2015 h, ending Hole U1499A. APC and XCB coring in Hole U1499A penetrated 659.2 m. As mentioned above, core recovery was highly variable and formation dependent; core recovery was a total of 417.05 m (63%). We suspect that unconsolidated sands accounted for the poor recovery intervals.

We then offset the ship 20 m to the east and conducted required routine rig servicing (drill line slip and cut). At 2345 h on 21 February, we started preparing the rig floor for assembling the reentry cone and 651 m long casing to be drilled into the seafloor at Hole U1499B.

We spent all of 22 February and the first part of 23 February assembling the 10.75 inch casing and the drilling string to be used to drill it into the seafloor. This included (1) moving the mud skirt over the moonpool, (2) assembling 651 m of 10.75 inch casing, lowering it through, and latching it into the mud skirt, and (3) assembling a 9.875 inch tricone bit, underreamer set to 12.75 inches, and mud motor, and lowering the assembly through the casing hung off in the moonpool.

At 0430 h on 23 February, we had finished putting together the final parts of the drilling assembly, attaching the upper part of the casing running tool (which contains the hydraulic release tool), and attaching the reentry funnel. We started lowering the entire 651 m long casing string and drilling assembly to the seafloor, and we deployed the camera system at 1115 h on 23 February to monitor the reentry funnel while the casing was drilled into the seafloor. When the pilot bit that extends 2.71 m below the cashing shoe was just above the seafloor, the drillers measured the pressures at various pump rates to get information to compare to the pressures measured when we start penetrating the formation. Drilling in Hole U1499B started at 1535 h on 23 February. While drilling the casing into the seafloor, we circulated 25 barrel mud sweeps at 152.6, 327.8, 356.98, 493.1, and 619.8 m. We continued to drill the casing into the seafloor until the mud skirt landed on the seafloor.

We deployed the go-devil to activate the casing running tool, which released the casing at 2300 h on 24 February. We retrieved the entire drilling assembly with the bit clearing the seafloor at 0230 h on 25 February, and the bit arrived back on the rig floor at 1230 h on 25 February. After taking apart the drilling assembly and flushing the mud motor, underreamer, and bit with fresh water, we began preparing the rig floor for RCB coring. We started assembling the RCB coring bottom-hole assembly at 1430 h on 25 February, and the rest of the day was spent lowering it to the seafloor. At 2230 h on 25 February, the subsea camera was deployed in preparation for reentering Hole U1499B.

Science Results

Scientists continued to acquire and analyze data from the final Hole U1499A cores and began summarizing these for presentations and reports. On 25 February, we held a meeting for the Expedition 367 laboratory groups to present a summary of their Hole U1499A results. At this meeting, we hosted at least 18 scientists from the next Expedition 368 who joined the meeting via videoconference from their workplaces and homes throughout the world (e.g., Europe, USA, China, India, etc.). The second half of this meeting will take place on Monday.

Lithostratigraphy

The core description team finished describing the last cores from Hole U1499A (Cores 31X–71X), and the visual core description (VCD) sheets have been updated accordingly. Four units were added to the lithostratigraphy summary for Hole U1499A, and a total of seven units have been defined.

Core recovery was poor (>30%) in the lower parts of the hole, especially in Cores 36X–43X and Cores 51X–65X (Units IV and VI). It is inferred from seismic reflection data, the drilling penetration rate, and the limited amount of sediment recovered that these intervals are predominately composed of unconsolidated sand and silt. In Cores 44X–50X, the primary lithology is bioturbated dark greenish gray clay with thin (<5 cm) interbeds of foraminiferal ooze (Unit V). At the bottom of the hole (Cores 66X–71X), the sediments become lithified as clay transitions to claystone with thin clayey siltstone and foraminifer-rich siltstone interbeds. These are tentatively assigned to Unit VII.

Biostratigraphy

This week the paleontology team performed analyses to the bottom of Hole U1499A (Section 71X-CC). Foraminifer and nannofossil preservation is moderate to poor, with some samples containing reworked species. The total abundance of foraminifera is very low in most of the samples. The rest of the week was spent reviewing and revising micropaleontological data collected, which led us to take 37 additional nannofossil samples. A total of 17 bioevents have been recognized and used to constrain the age model. The biostratigraphic results suggest that the sequence recovered in Hole U1499A is continuous and spans from the late Miocene to the late Pleistocene.

Paleomagnetism

The archive section halves at Hole U1499A were measured on the superconducting rock magnetometer (SRM) (model 2G760-4k) generating 31,489 measurements at 6,569 points along the recovered core. After measuring the natural remanent magnetization (NRM), the cores were subjected to a series of in-line alternating field (AF) demagnetization steps ranging from 3 mT to 30 mT. Declinations from Cores 1H through 18H were corrected using orientation data acquired with the Icefield tool. Inclination and declination data were used to determine a preliminary magnetostratigraphy. We were able to determine polarity for the interval above 162 m where we have constraints based on both inclination and declination.

Discrete samples were taken from most 1.5 m core sections resulting in a total of 160 discrete samples taken with Japanese boxes that were measured on the SRM and in-line AF demagnetized. Samples were initially demagnetized in steps ranging from 3 to 80 mT. Data at higher AF levels proved unreliable and later samples were only subjected to fields up to 45 mT. It was also determined that the AF coil cooling system is rated to 50 mT. Many samples showed

an anomalous increase in magnetization during the AF treatment making the results unreliable. We calculated the characteristic remanent magnetization (ChRM) for samples using the PuffinPlot software and principal component analysis. Discrete samples subjected to higher AF levels more reliably removed drilling overprint. Combining the discrete sample inclinations with the pass-through measurements allowed us to determine the polarity from the seafloor to just over 300 m near base of Unit IIIB. We also conducted thermal demagnetization on 52 of the discrete cube samples. Samples were heated to 350° without removing the drilling overprint, however, the magnetization level of the samples has decreased below what we can reliably resolve on the ship. Further thermal demagnetization will take place on shore.

We have developed an age-depth model in conjunction with the biostratography group. The paleomagnetic and paleontological age constraints match well.

Geochemistry

This week we finished analyzing portions of squeeze cake samples and selected samples from the sedimentologists for inorganic carbon, carbonate, total carbon, organic carbon, and nitrogen. All interstitial water samples were analyzed by ion chromatography (IC) for Mg, Ca, Na, K, chloride, sulfate, and bromide, and by inductively couple plasma–atomic emission spectroscopy (ICP-AES) for B, Li, Ba, Mn, Fe, and Si. Ammonium and phosphate were analyzed by spectrophotometry. The interstitial water (IW) depth profiles clearly show the typical redox zones, and are controlled by organic degradation, carbonate and clay diagenetic processes. Sediment samples are being prepared for analysis by ICP-AES and should be completed early next week.

Petrophysics

This week, physical properties measurements were completed for all sediment cores collected from Hole U1499A, as well as data processing and analysis. Data were plotted and correlated with the observed lithostratigraphy. A decrease in magnetic susceptibility (MS) and natural gamma radiation (NGR) can be observed in the carbonate-rich sediments of Unit II as well as in intervals of sands. Ash layers in the uppermost unit exhibit clear peaks in MS.

We also correlated our data with seismic reflection data by producing a synthetic seismogram using the caliper *P*-wave (PWC) velocity data from section halves as well as discrete and whole-round density data. Major reflector patterns match well with the information provided by the sediment cores.

Thermal gradient and heat flow calculated based on the thermal conductivity and in situ temperature measurements show relatively high heat flow, but similar to previous measurements in the surrounding area (e.g., sites from IODP Expedition 349).

Concentrations of K, U, and Th were estimated using NGR and bulk density measurements, based on a study from De Vleeschouwer et al. (2017), Quantifying K, U and Th contents of

marine sediments using shipboard natural gamma radiation spectra measured on DV *JOIDES Resolution*, G-cubed, DOI 10.1002/2016GC006715. These results will be used for further investigations.

Education and Outreach

This week the Education and Outreach Officer continued scheduling and planning video outreach events with schools in the USA, Italy, and China. An event with an Italian university was organized with the participation of one of the Co-Chief Scientists. Filming of short interviews with scientists was initiated. In addition, a multilingual activity involving several shipboard scientists was organized with a school group from Florida that sent styrofoam cups which the children decorated. These cups made a trip to 3758 m below sea level—just above the seafloor—on the subsea camera system while we drilled in the casing at Hole U1499B.

Technical Support and HSE Activities

Laboratory Activities

- Assembled dual G guns for upcoming check shot with VSI logging tool.
- Gave Protected Species training to new Marine Laboratory Specialists.
- See Developers section for additional laboratory issues.

Application Developer Activities

- Failure of the nonresponsive NGR sensor was isolated to the PMT. Repair targeted for Expedition 368 port call.
- New revision of SampleMaster was distributed.
- MagIC consortium provided updates to PmagPy (Python-based) utilities for reviewing and managing paleomagnetics data. Includes an updated tool to take LORE SRM data into the MagIC data formats.
- Continued remote participation with scoping of GeoDESC and Coulometer projects.

HSE Activities

- Eye wash and safety showers were tested.