IODP Expeditions 367 and 368: South China Sea Rifted Margin

Expedition 367 Week 6 Report (12–18 March 2017)

This week we (1) completed drilling and rotary core barrel (RCB) coring to 854.6 m in Hole U1500A, (2) drilled a reentry system with 842 m of casing into the seafloor in Hole U1500B, and (3) prepared to start deep RCB coring beneath the casing in Hole U1500B. All times in this report are in ship local time (UTC + 8 h).

Operations

This week we continued RCB coring in Hole U1500A; the primary operational objective was to determine the formation properties that will allow us to decide how much casing we will drill in the second hole at this site. This casing is necessary for us to achieve our primary expedition objective of coring and logging of the lowermost sediments and basement.

On 12 March, Cores 16R to 28R penetrated from 660.6 to 777.0 m and recovered 39.4 m (34%). Penetration rates within the upper part of this interval (17R to 23R, 660.6–728.5 m) were very quick (5–10 min) and we only recovered 6.67 m (10%). A formation change occurred at 728.5 m; Cores 24R–27R (728.5–767.3 m) took 30–50 min to cut and included substantially improved recovery (32.1 m; 83%) of clays/claystones. We thought this would be a good formation for the base of our planned Hole U1500B casing until Core 28R once again reentered a fast-penetrating, low-recovery interval inferred to be sands. Cores 29R to 36R penetrated from 770.0 to 854.6 m and recovered 27.6 m (36%). The majority of the core recovered was in Cores 30R, 33R, 35R, and 36R (25.29 m). For the other cores, penetration rates once again were very fast and recovery very low (2%–9%; inferred to be less consolidated silts/sands). When the last two cores (35R and 36R) encountered stable, well-consolidated formation, we decided we had met our primary objective of determining formation conditions at Site U1500 and an appropriate casing set point for our next hole. We pulled the bit out of the hole and it cleared the seafloor at 2330 h on 13 March. Based on the Hole U1500A information (cores, drilling, and borehole conditions), we decided to drill 842 m of casing into the seafloor. This will place the base of the casing in the relatively fine-grained stable formation we recovered in the last two cores and isolate the multiple intervals of unstable formation above (inferred sands/silts).

After the bit arrived back on the rig floor at 0640 h on 14 March, we disassembled the bit, cleared the rig floor, and conducted required routine rig servicing (drill line slip and cut). We then (1) prepared the casing running tool (hydraulic release tool [HRT]), and (2) assembled 842 m of 10.5 inch casing and latched it into the mud skirt sitting on the moonpool doors. We assembled and tested an 846 m long drilling assembly composed of a 9.875 inch tricone bit, underreamer (set to 12.75 inches), and mud motor. This drilling assembly was lowered through

the casing, the casing running tool (HRT) attached to the top of it, and then secured to the mud skirt/casing. At 1130 h on 15 March, the entire system was lowered through the moonpool and then to the seafloor. We deployed the subsea camera system at 2015 h on 15 March and installed the top drive shortly thereafter (2315 h).

At 0035 h on 16 March, we started drilling the casing into the seafloor in Hole U1500B. Along the way, we circulated 30 barrels of mud at multiple depths (335.6, 374.6, 394.0, 423.1, 452.2, 481.4, 510.6, 539.6, 568.8, 597, 627, 656, 685, 714, 744, 774, 802, and 832 m).

Drilling the casing into the seafloor proceeded smoothly until ~779 m (0800 h on 17 March) when we observed the mud skirt and reentry funnel rotate very quickly, indicating that torque had built up in the drill string and then suddenly released. At the same time, we also observed that the penetration rate slowed down substantially. We suspected that one or more of the underreamer arms had lost its cutting structure (roller cone). Our options at this point were limited to (1) continue to drill it in to the full depth or (2) pull it back to the ship, shorten the casing string, and try to drill that in. We had only ~63 m more of penetration until the casing was fully installed. Based on the coring information from Hole U1500A, much of this interval was expected to be loosely-consolidated fast-penetration formation with only a couple of short intervals of firm formation, so we continued to drill it in. Although penetration rates slowed quite a bit, we were able to continue advancing the entire system into the seafloor. This fact led us to suspect that if the underreamer cutters had come off, they likely had been pushed off into the borehole wall behind the casing. At 1740 h, a reduction in drill string weight indicated that the mud skirt had landed on the seafloor. We dropped the go-devil to activate the HRT, and at ~1833 h on 17 March the drilling assembly released from the casing. We raised the bit and underreamer back up to 841.4 m—inside the casing—and filled the annulus between the casing and the drill pipe with 100 barrels of mud to inhibit sand from being sucked back up into the casing as we pulled the drilling assembly out of the hole (as previously happened at Hole U1499B). We then pulled the drill string out of the hole. After the bit cleared the seafloor (2220 h on 17 March), we conducted a short survey of the reentry system, which was barely visible in the cutting mound.

Once we finished recovering the drilling assembly and the underreamer, we observed that all of its cutting structures were still attached. However, one of them was clearly damaged (failed bearing assembly) and likely the cause of the torque event and subsequent reduction in penetration rate. We started assembling the RCB bottom-hole assembly at 0915 h on 18 March and lowered it to the seafloor. We deployed the subsea camera system, started searching for the Hole U1500B reentry funnel, and after only 6 min of maneuvering we reentered Hole U1500B at 1845 h on 18 March. We recovered the camera system, lowered the bit down through the casing, and installed the top drive to prepare for RCB coring. At the end of the week, the bit was at 833.5 m, less than 10 m above the base of the casing.

Science Results

This week scientists submitted initial drafts of their Site U1499 reports to the Co-Chief Scientists for review and collected data on RCB cores from Hole U1500A.

Lithostratigraphy

We described Cores U1500A-13R to 36R and finalized the Hole U1500A stratigraphic column. RCB coring in Hole U1500A was limited to two intervals—from 378.2 to 494.6 m and 641.2 to 854.6 m. The cored section of Hole U1500A is divided into three lithostratigraphic units. Unit I (Cores U1500A-2R to 5R, 378.20–410.00 m) consists of dark greenish gray clay with very thin calcareous-rich clay and silt interbeds. Unit II (Cores U1500A-5R to 13R, 410.0–485.96 m) contains dark greenish gray sandstone and siltstone with foraminifer sandstone and claystone interbeds. The interval from 494.6 to 641.2 m was drilled without coring. Unit III (Cores U1500A-15R to 36R, 641.20–854.60 m) consists of dark greenish to dark gray sandstone and claystone with foraminfer sandstone and siltstone interbeds. Mud clasts occur in some sandstone layers throughout Unit III. We interpreted them as weakly consolidated clay that was eroded and then redeposited before completely being lithified. We also revised and submitted the Lithostratigraphy section of the Site U1499 report.

Biostratigraphy

This week the paleontology group finished all analyses of Hole U1500A core catcher samples (Samples U1500A-13R-CC to 36R-CC). In this section, the core recovery was low and many samples were barren. Therefore, some additional samples were collected from the split cores. Overall, more than half of the samples have moderate to good preservation.

The lower part of Hole U1500A is still in the late Miocene. Some important foraminifer species were observed in Hole 1500A that were not observed at Site U1499. These species are beneficial for establishing a clear biostratigraphy because of their relatively short duration. In addition, we also performed SEM analyses on the key species. We also finalized our Site U1499 report.

Paleomagnetism

This week we measured Core U1500A-2R through U1500A-36R on the cryogenic magnetometer and also started analysis of 33 discrete cube samples. These samples were in-line AF demagnetized on the cryogenic magnetometer with a maximum applied field of 45 mT. Discrete samples were analyzed on PuffinPlot and the polarity was used to create a magnetostratigraphy for Hole U1500A. Given the core recovery is only 28% and the recovered material only 11% of total penetration, we are not able to correlate the magnetostratigraphy to the standard timescale.

Geochemistry

This week we measured 21 headspace gas samples for routine safety monitoring in Hole U1500A. All collected samples exhibited values below detection limits except one with a low

value of 5.9 ppmv for ethane in Section 32R-1 (806 m). Nineteen discrete samples were also analyzed for carbonate content by coulometer and total carbon (TC), total inorganic carbon (TIC), and total nitrogen (TN) by elemental analyzer. Carbonate contents varied from <1 wt% to 34 wt%. Total organic carbon and total nitrogen were lower than 0.2 wt% and 0.06 wt%, respectively.

Petrophysics

This week, we measured physical properties on Cores U1500A-2R to 36R for whole-round measurements of magnetic susceptibility (MS), gamma ray attenuation (GRA) density, and natural gamma radiation (NGR), and for split-core measurements of thermal conductivity (TCON), *P*-wave measurements using caliper (PWC), as well as moisture and density (MAD) measurements on discrete samples.

NGR, GRA density, and MS decrease slightly from 380 to 410 m (NGR: 63 to 40 cps; GRA from 2.1 to 1.3 g/cm^3; MS from 97 to 22 × 10^{-5} SI), while *P*-wave velocity (caliper) is relatively constant (between 1590 and 1680 m/s). In the deeper section, between 730 and 850 m, no clear trend can be observed. In this interval, the data vary significantly: NGR is between 50 and 75 cps, MS is between 0 and 68 × 10^{-5} SI, GRA density reaches up to 2.4 g/cm^3, and PWC velocity is between 1845 and 2270 m/s with interbeds reaching values up to 4500 m/s. Grain density is ~2.6 g/cm^3 for Hole U1500A. Thermal conductivity increases from 1.1 to 2.0 W/(m·k). Our data set is severely impacted due to low core recovery as well as drilling without coring between 494.6 and 641.2 m.

Downhole measurements: We spent most of the week analyzing the Hole U1499B processed wireline log data (velocity, density, resistivity, natural gamma, FMS) and integrating it with core measurements and seismic data, as well as starting to use it to help constrain the formation characteristics in areas of poor core recovery.

Education and Outreach

This week the Education and Outreach Officer continued scheduling and planning live video-outreach events, including testing connection before the broadcasts, sending the teachers educational materials about the IODP program and the *JOIDES Resolution,* and conducting post-event surveys. The E/O Officer continued with the contest for the schools about the depth at which we will reach the basement at Site U1500. Routine posting to social media and to the *JOIDES Resolution* blog (http://joidesresolution.org) continued, including interviews with scientists to create blog entries. We also organized an outreach event with IODP Germany and one with the University of Pavia (Italy).

Technical Support and HSE Activities

Application Developer Activities

- In addition to routine operational and data management issues, developers assisted with analysis with data in paleomagnetics (spinner and SRM discrete) and moisture and density reports.
- Continued working on ongoing projects: LIVE, JANUS to LIMS (curation), and NCEI data migration automation.

HSE Activities

- Eye wash and safety showers were tested.
- A fire and boat drill was held.