

## **IODP Expeditions 367 and 368: South China Sea Rifted Margin**

### **Expedition 368 Week 3 Report (23–30 April 2017)**

The third week of the IODP South China Sea Expedition 368 consisted of (a) rotary core barrel (RCB) coring and downhole logging operations in Hole U1501D, (b) transit to Site U1502 (proposed Site SCSII-17A), and (c) drilling and RCB coring from 375 to 758.2 m in Hole U1502A. All times in this report are in ship local time (the same as in Hong Kong, UTC + 8 h).

### **Operations**

Week 3 started while RCB coring Hole U1501D at 625.2 m. Penetration rates slowed to under 2 m/h and core recovery increased below 606.1 m where we encountered massive sandstone. We changed the coring strategy to pulling the core barrel at half coring length (~4.7 m) to improve recovery by reducing the possibility of the core catcher being jammed with broken core material. We continued using this strategy to the final depth of 644.3 m. Following retrieval of the last core, we began to prepare the hole for logging. A 40-barrel mud sweep was pumped to clear the cuttings out of the hole, and a wiper trip was performed to 400 m and back down to total depth (TD). Approximately 40 m of fill was found at the bottom of the hole. The hole was washed to TD, and a 30-barrel mud sweep was pumped around, followed by a short wiper trip to 586.3 m and back down. Approximately 4 m of fill was found at the bottom of the hole this time. The rotary shifting tool was run in to release the bit, and heavy mud was spotted at the bottom of the hole. The top drive was set back and the bit was raised to a depth of 113 m for logging.

With an average heave of less than 0.5 m, a modified triple combo tool string was rigged up and lowered through the pipe and out into the open hole, but it hung up at approximately 173.3 m. After six attempts, the tool finally passed through with significant drag and then continued down the hole smoothly until it reached 299.3 m. At that depth, the full weight of the tool hung up, and even after more than ten attempts to pass, there was no advance. Our main pass was conducted with the caliper open, collecting magnetic susceptibility, resistivity, density, neutron porosity, and gamma radiation data. On the way up, there was a significant overpull (~1000 lb) in the vicinity of 173.3 m, and the caliper log indicated that the hole was collapsed to approximately the same diameter as the tool itself at 156.3 m. It was deemed unsafe to attempt to go below this depth with any subsequent passes, and since that was only about the length of the tool string below pipe, it was also deemed impractical to attempt any further runs. The tools were pulled out of the hole and rigged down without incident. The equipment was found to be in good condition upon returning to the surface.

After laying out the knobbies, the drill string was pulled out of the hole, clearing the seafloor at 1225 h on 24 April. The acoustic beacon was recovered at 1511 h. On 24 April, the end of the

mechanical bit release (MBR) cleared the rig floor, ending Hole U1501D and Site U1501. A total of 123.0 h (5.1 d) were spent on Hole U1501D.

The 36.5 nmi transit from Site U1501 to Site U1502 was made in 3.6 h, averaging 10.1 kt, and arriving on site (18°27.8720'N, 116°13.8381'E) at 2142 h on 24 April 2017. Upon arrival at Site U1502, a new C-4 RCB bit with an MBR was assembled onto the bottom of the bottom-hole assembly (BHA). The core barrel space out was checked and the BHA was run into the hole to 161 m. A precision depth recorder (PDR) measurement was taken on arrival, showing a calculated seafloor of 3768.4 m.

The bit was lowered to a depth of 3744 mbrf with the string being filled every 20 stands. The upper guide horn was pulled and the underwater camera system was deployed to observe the seafloor tag. While the camera was being lowered, 115 ft of drill line was slipped and cut. After the slip and cut operations were completed, the bit was spaced out to 3750.7 m and slowly lowered until it was observed that the bit had tagged the seafloor at 3763.7 m. The underwater camera was retrieved and a center bit was dropped and landed in the BHA. The bit was lowered and Hole U1502A was spudded at 1300 h on 25 April. The hole was advanced without coring to a depth of 375 m in 18 h. The center bit was pulled and an RCB core barrel dropped to begin coring operations.

Cores U1502A-2R through 7R drilled very quickly and had little recovery, which was interpreted as an unconsolidated sandy interval. Penetration rates slowed for Cores U1502A-8R through 14R and recovery improved through this mudstone interval. Recovery subsequently decreased in what was interpreted as another unconsolidated sand interval from 499.5 to 585.9 m (Cores U1502A-15R through 23R). A second mudstone interval was sampled with very good recovery from Core U1502A-24R at 585.9 m to Core U1502A-39R at 739.1 m. The last 2 m of the following core, U1502A-40R, drilled very slowly, indicating a major change in formation. One more core was drilled to confirm the continuity of the formation change for a casing set point. At that point, it was decided to terminate coring in Hole U1502A in favor of continuing coring in a cased hole. The drill string was pulled to the surface, clearing the rotary table at 0330 h on 30 April, ending Hole U1502A and beginning Hole U1502B.

Total time spent on Hole U1502A was 125.25 h (5.2 d). The RCB coring system was used exclusively. Overall there were 40 cores taken over a 383.2 m interval with 176.81 m of recovery (46.1%).

## **Science Results**

This week scientists acquired and analyzed data from Holes U1501D and U1502A, and they began summarizing their results for presentations and reports. On 25 April the Co-Chief Scientists presented the scientific objectives and operations plan for Site U1502, and they held a

pre-spud meeting with key Siem Offshore personnel, the Logging Engineer, and JRSO technical staff. On 27 April we held a meeting to present and discuss the Hole U1501D data. At this meeting, we hosted 15 scientists from Expedition 367, who joined the meeting via videoconference. By the end of the week, the initial drafts of all Site U1501 reports had been submitted for review to the Science Office.

### *Lithostratigraphy*

Cores from Holes U1501D (Cores 20R–27R) and U1502A (Cores 2R–41R) were described using a combination of visual core description (VCD), microscope inspection of smear slides, core imaging, and core scanning for color spectra and magnetic susceptibility. Three lithologic units have been defined at Site U1501.

Units I and II are each subdivided into six subunits, and Unit III is subdivided into two subunits. Lithologic Unit I (Cores U1501C-1H-1, 0 cm, through 45X-1, 51 cm) is predominantly greenish gray to light brownish gray clay-rich nannofossil ooze and nannofossil ooze with clay. Unit II consists of interbedded greenish-gray to dark greenish-gray glauconite bearing nannofossil ooze, clayey silt to sand, partially lithified sandstone with abundant calcite, and an interval of clayey silt that is intercalated by organic-rich layers. Lithologic Unit III is composed of light to dark gray sandstone with gravel.

At Site U1502, Cores U1502A-2R to 13R sampled intercalated layers of gray clay to silt-rich nannofossil ooze, brownish silty clay with nannofossils, greenish gray silty clay, and occasionally fining upward sandy silt intervals. Calcareous nannofossil content markedly decreases in Cores U1502A-12R and 13R, while the amount of diagenetic calcite increases. Cores U1502A-14R to 30R consist of brown clay interbedded with greenish gray clay and sandy silt, except for Core 25R, which revealed a grayish pink siltstone, a greenish gray sandstone, and foraminiferal chalk. From Core U1502A-31R to 35R, brownish to reddish clay and silty clay predominate. Bioturbation is moderate to heavy.

### *Biostratigraphy*

All core catcher samples from Hole U1501D (Cores 2R-CC to 27R-CC) were processed for diatom, calcareous nannofossils, and foraminifer examination. All core catcher samples, except for U1501D-8R-CC and 19R-CC, were barren of diatoms. Likewise, all samples were barren of calcareous microfossils, except for a short interval between Cores U1501D-2R (443.1 m) and 5R (471.8 m), which yielded mainly benthic foraminifera and ostracoda. The benthic assemblage indicates a shallow water marine paleoenvironment. Calcareous nannofossils found in these samples provide an age estimate of middle Eocene for the section.

In Hole U1502A, a total of 61 samples were processed for diatoms, 51 samples for calcareous nannofossils, and 45 samples for foraminifera analyses. Diatoms are present and abundant only in Section U1502A-40R-1. Seven planktonic foraminifera and six calcareous nannofossil

biostratigraphic events were recognized and provide a late Miocene to late Oligocene age for the interval between 376 and 758 m in Hole U1502A.

### *Paleomagnetism*

Archive section halves from Cores U1501C-48X to 62X, Cores U1501D-2R, 3R, and 20R, and Cores U1502A-2R to 18R were measured on the superconducting rock magnetometer (SRM) at 2.5 cm measurement space. After measuring the natural remanent magnetization (NRM), the cores were subjected to a series of step-wise in-line alternating field (AF) demagnetization steps at 5, 15, and 25 mT (the 10 mT step was omitted to save time and keep up with core recovery). For Cores U1501C-48X to 60X only NRM was measured due to the very weak magnetization of the material. Inclination and declination from Hole U1501D were plotted against depth to determine a tentative magnetostratigraphy.

A total of 151 discrete samples were collected from even core sections from Holes U1501C and U1501D, and 29 were collected from Hole U1502A, taking two specimens from each sampled section to perform and compare results of AF and thermal demagnetization. Samples were shared with the physical properties group when recovery was less than 20%. We stopped collecting samples for thermal demagnetization after Core U1501C-21F due to low recovery. We restarted collecting samples for thermal demagnetization in Holes U1501D and U1502A. The change in the sampling strategy was motivated primarily because we encountered more complex magnetic assemblages (possibly with two or three phases, including a high coercivity phase) for which thermal demagnetization has been proved to be more effective.

After measuring the NRM, AF demagnetization was performed on 99 samples at 5, 10, 20, 30, 40, and 50 mT using the DTECH (model D-2000) AF demagnetizer. We calculated the characteristic remanent magnetization (ChRM) for discrete samples from Hole U1501C using the PuffinPlot software and principal component analysis. Adding the discrete sample inclinations to the depth plots allowed us to validate the polarity observed in the core section with the SRM data.

For Hole U1501D, we tentatively interpreted a long normal polarity interval below  $T_g$  as one of the long normal polarity intervals of the Cretaceous (Chron C33 or higher).

### *Geochemistry*

We continued to collect headspace gas samples from each core for routine safety program, and high methane levels were not detected in any core from Hole U1502A. Interstitial water samples were also successfully obtained down to ~550 mbsf. They yielded very high alkalinities typical of subsurface formation water. Sample processing for measurements of solid organic geochemical parameters for Site U1502 were started, with more data expected next week. Third party instrument measurements were used to evaluate the past thermal maturation history at Site U1501, and the geochemists are considering a shipboard temperature programmed pyrolysis to

support early findings. Geochemists and laboratory technicians have been surprised by the extent of recovery of formation water from such deep cores at Hole U1502A.

### *Physical Properties*

This week we made whole-round core measurements of velocity, density, magnetic susceptibility, and natural gamma radiation for Hole U1501D. Whole-round measurements on Cores U1502A-2R to 32R are already completed. We continue with the same measurement spacing used for Site U1501. Moisture and density, *P*-wave velocity, and thermal conductivity measurements on split cores have been completed for Hole U1501D and are currently underway for Hole U1502A.

*P*-wave velocity for Hole U1501D ranges from 1767 m/s at 434 mbsf to 4814 m/s at 643 mbsf, and the thermal conductivity ranges from 1.32 W/(m·K) at 439 mbsf to 3.52 W/(m·K) at 642 mbsf. The *P*-wave velocity for Hole U1502A ranges from 1735 m/s at 336 mbsf to 1948 m/s at 587 mbsf, and the thermal conductivity ranges from 1.65 W/(m·K) at 376 mbsf to 1.87 W/(m·K) at 674 mbsf. Overall, physical properties show variabilities with burial, which may be related to changes in lithification, bioturbation, grain-size, carbonate, and water content in the material.

### **Education and Outreach**

The Education/Outreach team started interviewing the scientists and formatting and editing the stories for blog posts and other media outlets. The U.S. Education/Outreach Officer spent the week conducting live broadcasts with schools, scheduling other education and outreach broadcasts, and communicating them to the crew and scientists. She produced blog stories daily and semidaily depending on the broadcast schedule at <http://joidesresolution.org>, and promoted Expedition 368 on social media. Additionally, she started researching for the curriculum development project around microfossils and climate change.

The Chinese journalists produced several news media pieces including news articles, broadcasts, and daily new columns. One article on the foam cups brought from Shanghai made the first page of Science and Technology Daily on 25 April. Another article made the news (<http://www.kankanews.com/a/2017-04-26/0037968059.shtml>). Additionally they took drone footage of the ship on site, posted blogs and news on Weibo, the Chinese microblogging site, and produced and broadcast several videos, including short TV news reports for SMG News in China. They also conducted a live broadcast to a primary school of Tongji University.

## **Technical Support and HSE Activities**

### *Laboratory Activities*

- Superconducting rock magnetometer (SRM): an unexpected trip of the ship's chill water circulation pump triggered the alarm on the cryo-compressor and then shut it down safely. It was several hours before the ship's chilling system was online and the compressor could be restarted. We successfully nulled and trapped a new field and resumed measurements.
- Section Half Imaging Logger: the SHIL is now correctly extracting RGB data from the core section images. All measured data from Expedition 368 cores have been corrected. Expedition 367 data will be reextracted during the casing operations and sent to shore for upload.

### *Application and IT Support Activities*

- Superconducting rock magnetometer:
  - Corrected and reuploaded the data that were affected by the code changes done to the software during port call.
  - Corrected a core sample depth calculation problem with the discrete sample data files.
- Modified the MegaUploadatron (MUT) system to automatically generate thumbnails used by the LIVE core data viewing application when images (SEM, TSIMAGE, or MICROIMG) are uploaded.
- Corrected several minor bugs in LIVE reported by users.

### *HSE Activities*

- The weekly fire and boat drill was postponed until Monday due to the casing operations at Site U1502.