

IODP Expeditions 367 and 368: South China Sea Rifted Margin

Expedition 368 Week 6 Report (14–20 May 2017)

This week we (1) traveled to Site U1503 (proposed Site SCSII-9B), (2) drilled without coring in Hole U1503A to 902.8 m to prepare the hole for subsequent installation of 10.75 inch casing, (3) deployed a free-fall reentry cone, then (4) assembled the 10.75 inch casing string and drilling assembly before we had to stop operations until spare parts for the drawworks were delivered to the ship at the end of the week. All times in this report are in ship local time (the same as in Hong Kong, UTC + 8 h).

Operations

The *JOIDES Resolution* began the transit from Site U1502 (proposed Site SCSII-17A) to Site U1503 (proposed Site SCSII-09B) in dynamic positioning (DP) mode while pipe was being tripped. The mud skirt and reentry cone to be used at Site U1503 were then moved to the center of the moonpool and stationed on the moonpool doors. With this secured, the thrusters were pulled and the vessel was underway at full speed at 0806 h on 14 May.

The vessel arrived on site at 0930 h on May 15 to find a Chinese research vessel (R/V *Shiyan 2*, operated by the South China Sea Institute of Oceanology) conducting a seismic survey in the area. Because of this, the *JOIDES Resolution* was unable to occupy the site until 1130 h on 15 May. The vessel completed the 19.8 nmi voyage from Site U1502 in 8.6 h (7.2 h in DP mode and 1.4 h at cruise speed).

Once on site, a positioning beacon was deployed and the crew made up bottom-hole assembly (BHA) with a 14.75 inch bit to drill a hole without coring to 1000 m for installation of 10.75 inch casing. The bit was lowered through the reentry cone and base that was assembled and placed in the moonpool. A precision depth recorder (PDR) measurement had been taken upon arrival, placing the seafloor at 3873.1 mbsl. The bit was lowered to 3846 mbsl, the top drive was picked up, and the bit was spaced out to spud Hole U1503A. The hole was started at 2010 h on 14 May and was advanced to a depth of 902.8 m below the seafloor at 0100 h on 16 May. At this time, the rig mechanic noticed a leak in the low clutch diaphragm, which had already been replaced twice during the expedition. It was decided to pull the bit to the surface before the diaphragm failed completely. The bit was pulled to 97.6 mbsf and the reentry cone assembly was free-fall deployed. The subsea camera was lowered to observe the landing orientation of the cone. Once the camera was near the sea bottom, the bit was pulled out of the hole, clearing the seafloor at 0750 h on 16 May. The bit tagged the internal aperture of the cone to establish seafloor depth of at 3867.7 m, 5.4 m higher than previously thought. The hole depth was adjusted to 908.2 m.

The bit was then pulled to 3846 m and 215 ft of drill line was slipped and cut. The bit was pulled to the surface, clearing the rotary table at 1655 h. With no spare clutch diaphragms aboard and delivery of spare diaphragms delayed until approximately 20 May, it was decided to move along with all possible operations without using the low drive on the drawworks.

The drill crew ran 85 joints (989.3 m) of 10.75 inch casing and crossed over to a 16 inch casing hanger. While attempting to engage the DrilQuip running tools, it was noted that the seal diameter on the casing hanger was too small. The crew modified the hanger to enlarge the seal diameter and engaged the running tool. The casing was then lowered into the moonpool and hung off the moonpool doors.

The crew then picked up the mud motor and underreamer, lowered the drilling assembly into the moonpool, and tested them. The rest of the drilling assembly was made up and lowered through the casing. The running tool was then reengaged into the casing hanger and the entire casing string and drilling assembly was lowered as far as possible (2379 m) without using the drawworks low clutch, then hung off the traveling blocks. Our last operation was to make up three stands of knobbies and pump a pig through each stand to clean any rust—these were then racked back in the derrick for use when drilling in the casing.

The rig then went on downtime on Thursday 18 May at 0915 h until the replacement parts (low clutch diaphragms) were delivered to the ship at 2310 h on 20 May. The seagoing tug *M/V Taikoo* arrived on site with three spare low clutch diaphragms. The tug stationed itself on port aft side of the *JOIDES Resolution*. Supplies were offloaded and the tug departed by 2320 h. At the end of the week, the crew had begun replacing the low clutch diaphragm.

Science Results

This week, scientists finished acquiring and analyzing data from Site U1502, and they submitted initial drafts of their site reports to the Co-Chief Scientists and Expedition Project Manager for review. We presented our ongoing results in daily crossover meetings, and a summary of all the results from Site U1502 were presented in a 1.5 h meeting on Wednesday, which also was attended by Expedition 367 scientists via the shipboard videoconferencing system.

Lithostratigraphy, Petrology, and Structural Geology

After completing training on the safe use and procedures for the handheld XRF-analyzer, members of the core description team conducted systematic measurements of Cores U1502B-2R to 37R, as well as on the thin section billets of basalts from Expedition 367 Site U1500.

The pXRF data of the basalts sampled in Hole U1502B show that Igneous Unit 2a (Cores 368-U1502B-4R to 12R; 739.2–801.5 m, basaltic breccia and brecciated basalt) is the most altered, particularly by the strong leaching of oxides (e.g., FeO, MgO and MnO) towards the top of the

section. Measurements of Unit 2b (Cores U1502B-12R to 37R; 801.55–920.95 m, moderately to highly altered, less brecciated basalt) do not reveal the same strong overall alteration, but show a higher variation, with the highest FeO, CaO, and lowest (typical basalt) Zn values for the optically least altered basalts that have a high magnetic susceptibility. Fluid immobile elements such as Zr and Ti are relatively constant throughout the Unit, indicating little geochemical variation of the Unit before alteration. Zr and Ti in Unit 2 are typical for mid-ocean ridge basalt, while the few samples recovered from Igneous Unit 1 suggest a more enriched signature.

The core description team also updated the visual core description (VCD) sheets and thin section reports, and they submitted the Lithostratigraphy, Igneous Petrology, and Structural Geology sections of the Site U1502 report.

Biostratigraphy

This week the paleontology group completed the Site U1502 report, which documents an early Oligocene to late Miocene succession recovered in Hole U1502A. Calcareous and biosiliceous microfossils are absent from Hole U1502B, and only one sample from Core U1502B-3R yielded an assemblage of abundant and diverse agglutinated benthic foraminifera. A comparison of this benthic assemblage with one of similar composition found at ODP Site 643 suggests an Eocene age for Core U1502B-3R.

The paleontologists also reexamined selected core catcher samples and smear slides from Cores U1500B-46R to 56R to reevaluate the biostratigraphic time-depth correlation with two of the most important basin-wide unconformities recognized in the seismic stratigraphy of Site U1500 and our current site, U1503. A significantly revised biostratigraphic interpretation is proposed, and a report is being prepared for sharing it with the Expedition 367 science party for consideration and discussion.

Paleomagnetism

SRM data from Hole U1502B was checked for errors, and all duplicates, erroneous sample numbers, and other discrepancies were corrected. All 13 discrete samples collected from Hole U1502B for alternating field (AF) demagnetization were measured up to 120 mT.

Data analysis, including statistical analysis with KaleidaGraph using point magnetic susceptibility (κ) measurements and pXRF chemical analyses showed the lack of correlation between major or trace elements and κ . This suggests that κ cannot be taken as a proxy for degree of alteration. The spatial correspondence between intervals of high κ and high alteration (not quantified) most likely results from selective alteration of volcanic units with high permeability. The massive aphyric basalt units (e.g., Core section U1502B-37R-1W) are least altered likely because they are macroscopically less permeable. Koenigsberger ratios were calculated for the basalts of Site U1502 to assess their potential contribution to magnetic anomalies. Preliminary analysis suggests that altered basalts (hosting maghemite or hematite)

might contribute more than fresh basalts due to the low coercivity of titanomagnetite in these fresh rocks. A preliminary analysis of the anisotropy of magnetic susceptibility (AMS) shows that most samples carry an AMS below the value considered meaningful ($P \approx 1.01$). Any post-cruise AMS research would require using a large number of samples to improve the statistical significance of measurements.

An experiment was performed by the Laboratory Officer in coordination with the Captain that consisted of slowly rotating the ship while continuously measuring the x , y , and z components on the SRM. This experiment showed a very significant variation of the background measured in the SRM, particularly on the z -axis. This should not affect measurements because the background is always measured and subsequently subtracted before each section measurement.

Geochemistry

A final batch of trace element data for both rocks and formation water was successfully measured for major elements on the ICP before the instrument failed irreparably on 16 May. No other ICP measurements will be possible for the rest of the expedition. The ICP data from Sites U1501 and U1502 were particularly interesting for formation water and brought to light some important geochemical differences between the two locations. The interstitial water from Hole U1502A is enriched in alkalinity and sulfate and has a higher pH than both modern seawater and most other interstitial water obtained in the region (including Expeditions 349, 367, and 368). The concentrations of dissolved Fe, Si, and Li of interstitial water samples from Hole U1502A generally increase with depth, and the maxima are much higher than the values of modern seawater and Site U1499.

Physical Properties

Three petrophysical units were defined in Hole U1502B. PP Unit 1 extends from 727.7 to 740 m and is associated with a strongly lithified limestone. This unit exhibits high NGR values (50–80 cps) and bulk density (up to 2.7 g/cm^3), and low porosity ($\sim 3\%$).

PP Unit 2 (740 to 808 mbsf) represents the strongly altered basalts and is characterized by relatively low NGR values (< 10 cps), and wider range of P -wave velocities (3000 to 4000 m/s). Bulk densities in PP Unit 2 range from 2.1 to 3.3 g/cm^3 , and porosity ranges between 3% and 40% , while thermal conductivity ranges from $1.9 \text{ W/(m}\cdot\text{K)}$ to $2.3 \text{ W/(m}\cdot\text{K)}$. The boundary between PP Unit 2 and 3 is marked by an abrupt increase in density, P -wave velocity, and thermal conductivity, and coincides with the change from brecciated basalt to phyrlic basalt. In PP Unit 3 (808 to 920.8 mbsf), which corresponds to the moderately to highly altered basalt, grain density is highly variable (2.7 – 3.1 g/cm^3), while bulk density is relatively constant at $\sim 2.3 \text{ g/cm}^3$.

Downhole Measurements

We spent most of the week analyzing the processed wireline log data (acoustic velocity, density, resistivity, and natural gamma radiation) from Hole U1502B, and integrating them with core measurements and seismic data.

Education and Outreach

The Education/Outreach team continued to interview the scientists to create stories for blog posts and other media outlets. This week, the Education/Outreach Team conducted eight broadcasts and reached 258 students across the world. As of now, they have coordinated the outreach to 1135 students at schools and universities across the world during this expedition.

The U.S. Education/Outreach Officer scheduled educational and outreach broadcasts, and communicated them to the crew and scientists through the weekly calendar. She produced blog stories daily and semidaily depending on the broadcast schedule at <http://joidesresolution.org>. She promoted Expedition 368 on social media (Facebook (<https://www.facebook.com/joidesresolution>), Instagram (http://instagram.com/joides_resolution), and Twitter (<https://twitter.com/TheJR>), #exp368). Additionally, she met with several scientists and colleagues for her research for the curriculum development project around microfossils, evolution, and climate change over time.

The Chinese journalists produced several news media pieces including news articles, broadcasts, and live education/outreach broadcasts with a middle school in Tianjin and a primary school in Beijing, and daily diary columns. They also posted blogs and news on Weibo, and produced and broadcast several videos, including short TV news reports for SMG News in China, and several articles for Science and Technology Daily:

1. A TV News Report: www.kankanews.com/a/2017-05-17/0017993160.shtml
2. Article: www.kankanews.com/a/2017-05-16/0037992255.shtml
3. Articles on Science and Technology Daily:
Why scientists need to tell their stories (15 May):
http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2017-05/15/content_369369.htm?div=-1
Vertical Seismic Profiles (published on the first page of STD, 17 May):
http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2017-05/17/content_369505.htm?div=-1
4. Research by the *JOIDES Resolution* and R/V *Shiyan 2*:
http://www.stdaily.com/cxzg80/kebaojicui/2017-05/15/content_543682.shtml

Technical Support and HSE Activities

Laboratory Activities

- Chemistry Laboratory ICP: After nearly a week of troubleshooting with the vendor's technical representative, we have concluded that the ICP is irreparable without a spare oscillator tube. A service call is being arranged for the Townsville port call.
- Logistics: Removed the last damaged D-tube boxes from the core reefer. We have built three pallets (~400 D-tubes). After the cores are shipped, another three pallets would allow for all of the D-tubes to be cleared from the core reefer for tie-up work.

Other Activities

- Staff have taken an opportunity with our coring break to cross-train in the laboratories and update manuals.
- The Schlumberger Logging Engineer is conducting a basic electronics class for staff and science party.
- Staff received training on how to setup and calibrate the Section Half Imaging Logger (SHIL).
- Physical counts and inventory updates were conducted.

Application and IT Support Activities

- Crossover with onshore developers regarding the Coulometer project.
- Modify LDAQTest ResourceManager to handle LabView DLL.
- Research and experiment with methods to load LabVIEW DLL into C+ applications.
- Worked with Laboratory Officer on advanced LabView techniques to customize controls to make them look polished and professional.
- Coded DataManagerActor functions with Java.
- Continue work on measure-display actor.
- Internet service was unavailable between 0645 h and 0730 h ship time Friday morning due to bad weather.
- Dell firewall support recommended a change to the ship's configuration to resolve communication issues relating to the Hewlett Packard storage device's inability to connect to HP Enterprise monitoring service. The change was carried out Tuesday morning and required a restart of the firewall. There have been no reports of impact from the user community.
- Due to the recent outbreak of a malware targeting unpatched Windows computers, all of the ship's computers running Windows have been checked for proper patching. Patches were applied where needed. The downtime in drilling activities allowed us much needed access to computers in critical areas of operation, including the Drill Shack and science laboratories.

HSE Activities

- Held the weekly fire and boat drill as scheduled.
- All safety equipment has been checked.
- Handheld XRF weekly safety survey conducted.