IODP Expeditions 367 and 368: South China Sea Rifted Margin

Expedition 367 Week 4 Report (26 February–4 March 2017)

After installing 651 m of casing in Hole U1499B last week, we spent the entire week rotary core barrel (RCB) coring below the casing from 655.0 to 1013.9 m. All times in this report are in ship local time (UTC + 8 h).

Operations

The week started with lowering the RCB bit and camera to the seafloor, after which we started searching for the Hole U1499B reentry funnel at 0215 h on 26 February. After we were unable to find it relatively quickly (as is usual), we initiated an expanding 5 m grid search. After just over 6 h, we eventually found the reentry funnel cone, which was clearly visible inside a small crater of sediments. The top of the reentry funnel appears to be close to level with the top of the cuttings pile. After only 10 min of maneuvering, we reentered Hole U1499B at 0825 h on 26 February, started lowering the RCB bit down through the casing, and recovered the camera system. As the bit was being lowered, it encountered sediment inside the casing at 571 m, which is 80 m above the casing shoe. This was assumed to be sand that was drawn back into the casing as the drilling stinger assembly (with pilot bit, underreamer, and mud motor) used to drill the casing in was withdrawn from the casing. We picked up the top drive, deployed a core barrel at 1230 h and washed back to the bottom of the hole at 655 m (4 m below the base of the casing). We circulated 30 barrels of mud, retrieved the core barrel (empty), and at 2230 h on 26 February, we started RCB coring in Hole U1499B.

On 27 February, RCB coring in Hole U1499B penetrated from 655.0 to 790.8 m with an overall recovery of 41.44 m (Cores U1499B-2R to 15R; 31%). However, recovery continued to be highly variable and formation dependent. In fine-grained intervals, we had higher recovery (53%) and steady, relatively slow penetration rates (Cores U1499B-2R to 3R, 655.0–674.4 m; 9R to 10R, 722.9–742.3 m; and 13R to 15R, 752.0–790.8 m). In coarser intervals, inferred to be loosely consolidated sands, we had very low recovery (0.7%) and very fast penetration rates. We circulated 30 barrel mud sweeps at 684.1, 713.2, 742.3, 761.7, and 781.1 m. At first light on 27 February, a boat (M/V *Taikoo*) with critical spares for the drawworks clutch arrived on site and the transfer was completed.

We continued RCB coring from 790.8 to 897.5 m (U1499B-16R to 26R; 72.33 m recovered; 68%) and circulated 30 barrel mud sweeps at 810.2, 839.3, and 878.1 m. Each of these cores (16R to 26R) took from 20 to 60 min to cut. The drillers also noted another fast drilling zone from 825.0–834.0 m. After Core 26R, however, we encountered a substantial formation, when Core 27R took 205 min to cut. RCB Cores U1499B-27R to 29R continued in very hard formation. These cores took 120 to 205 min to cut, penetrated 29.1 m from 897.5 to 926.6 m, and recovered 16.43 m (56%). However, Core 30R took only 45 min to cut, as opposed to the cores above (27R, 205 min; 28R, 130 min; and 29R, 120 min). In addition, when raising the bit off bottom to recover the core, the drill string became stuck momentarily, so we circulated 30 barrels of mud and hole conditions improved. The penetration time for Core 31R went back up (130 min), but the drill string became temporarily stuck again; this time we circulated 90 barrels of mud and coring was able to continue.

RCB Cores U1499B-31R to 38R penetrated 77.6 m from 936.3–1013.9 m and recovered 8.66 m (11%). It took 2 to >3 h to cut each core. The drill string became stuck momentarily while cutting Core 33R. We circulated 30 barrels of mud after cutting Cores 32R and 35R–37R.

Because we decided to stop coring to change the RCB bit (40.6 rotating hours), we circulated the cuttings out of the hole with 70 barrels of mud after Core 38R. Before pulling the bit up into the casing and out of the hole, we first raised the bit up to 780 m, circulated the hole with 35 barrels of mud, and then filled the uncased (open) part of the hole with 235 barrels of heavy mud (11.0 ppg). This was intended to help stabilize the hole while we changed the bit and reduce the amount of fill we might encounter when reentering the hole to resume RCB coring. This was also expected to give us some indication of hole conditions we might encounter for planned downhole logging after coring is completed. Since we had some challenges locating the hole the first time we reentered, we lowered the subsea camera system to observe the reentry funnel as we pulled the bit out of the hole. While we were still in the hole, we could see the drill pipe clearly in the center of the crater created by the cuttings mound. Although the reentry funnel's concentric black and white stripes were not visible, we didn't anticipate problems finding and reentering the hole. The bit was pulled out of the hole at 1655 h on 3 March and we spent the rest of the day recovering the drill string (except for a 0.5 h repair of the pipe racker).

We finished recovering the drill string at 0215 h on 4 March, attached a new RCB bit (C-7), lowered it to the seafloor, and then deployed the subsea camera system at 0915 h. We paused rig floor operations for 1.5 h to conduct required routine rig servicing (drill line slip and cut) before we resumed lowering the drill bit to the seafloor. At 1345 h on 4 March, the bit and camera were in position and we were immediately able to see the reentry funnel in the center of the cuttings pile crater. It took us 22 min to position the bit over the funnel and reenter Hole U1499B at 1407 h on 4 March. We retrieved the camera and lowered the bit down through the 651 m of casing and down to 848.1 m in the open hole. We installed the top drive and circulated/rotated until 987 m—only ~27 m from the bottom of the hole—before the bit encountered any resistance, which was easily penetrated. We only encountered 1 m of fill on the bottom of the hole. At the end of the day, we pumped 40 barrels of mud to clear cuttings from the hole and we were retrieving the core barrel that was in place while getting back to the bottom of the hole. We will resume RCB coring from 1013.9 m.

Science Results

This week scientists (1) continued to analyse and summarize Hole U1499A data, and (2) acquired data from the Hole U1499B RCB cores. We also held our second meeting for the Expedition 367 laboratory groups to present a summary of their Hole U1499A results. Once again, scientists from the next expedition (368) joined the meeting using the shipboard videoconferencing system.

Lithostratigraphy

Cores U1499B-2R to 38R were described. The top six cores are a continuation of Unit VII from the base of Hole U1499A. These cores are dark greenish gray siltstones and claystones with some low recovery zones that are inferred sandy intervals. In Core 13R, there is a gradual transition to a dark brown claystone, which marks the transition to Unit VIII.

Unit VIII extends from Cores 13R to 30R. It comprises dark brown and brownish red claystone with zones of light greenish gray claystone. The green color is interpreted to be an alteration product and is often located around interlaminated silts and sands, fractures, or individual foraminifer tests. Bioturbation remains moderate to heavy throughout. The brown claystone becomes redder as depth increases. Cores 26R–30R are lighter in color and have reduced magnetic susceptibility and natural gamma radiation, which we interpret to reflect an increase in carbonate content. Thus, we separate these cores into a Subunit VIIIB. Iron-manganese nodules in claystone are observed in Section 30R-2, and are underlain by a greenish to brownish gravel-rich sandstone, and a greenish matrix-supported breccia with polymict clasts below. This transition defines the top of Unit IX. The base of Core 30R exhibits another transition from matrix-supported breccia to sandstone and breccia cobbles, which continues downhole through Core 38R. There are several different sedimentary lithologies represented in the breccia clasts.

Biostratigraphy

The paleontology team performed analyses of core catcher samples from Cores U1499B-2R to 38R. More detailed sampling and analyses were conducted on Core 30R (12 samples) to constrain a general Oligocene biostratigraphic frame for this core. Foraminifer and nannofossil preservation is poor to common, with some samples containing reworked species. Both foraminifera and nannofossils are barren from Cores 31R to 38R, and the abundance of foraminifera ranges from present to rare from Cores 2R to 30R. A total of 40 and 50 samples were analyzed for foraminifera and nannofossils, respectively, and a total of 14 bioevents were recognized.

The biostratigraphic results suggest that the sequence recovered from Cores 2R to 38R spans from the late Miocene to the early Oligocene. Section 24R-CC is at the boundary of late to middle Miocene, while Section 25R-CC is in the early Miocene around 18 Ma, suggesting that a low sedimentation rate or a hiatus occurred between these cores. The boundary between Miocene and Oligocene is around Core 27R based on nannofossil data, and at Core 29R based on foraminiferal results. Core 30R spans from the late Oligocene in Sections 30R-1 and 2 to the early Oligocene in Sections 30R-5 and 6.

Paleomagnetism

We have measured all archive core sections through Core U1499B-30R on the superconducting rock magnetometer. From Core 12R on, the color of lithology changed from greenish gray to dark brownish with relatively higher magnetic susceptibility, and the rocks were barely affected by the drilling overprint. For Cores 27R and below, the magnetic susceptibility dropped about one order of magnitude, the drilling overprint became stronger, and drilling disturbance became worse, all contributing to making paleomagnetic analysis in those intervals problematic. Our discrete sample interval was reduced and restricted to only the most intact pieces. Changes in the magnetic mineralogy have resulted in lowering of the intensity of the natural remanent magnetization and in the effectiveness of alternating field (AF) demagnetization. Using AF and thermal demagnetization of discrete samples, we have determined that they likely contain both magnetite and hematite. AF fields up to 200 mT do not demagnetize the samples and temperatures in excess of 675°C will be needed to fully demagnetize the samples.

Geochemistry

Headspace gas content of 31 samples taken this week in Hole U1499B was close to zero in most cores. Seventeen samples for inorganic carbon, carbonate, total carbon, organic carbon, and nitrogen analysis were also completed. Carbonate content fluctuated between 38.0% and 0.7%, and OC was lower than 0.4%.

The bead maker for the ICP has a problem that can't be fixed during this expedition (it awaits a new part being delivered to Hong Kong). Attempts to fuse sediment samples for ICP-AES analysis using alternate methods (placing the crucibles in the oven) has not yet produced useable beads; these analyses might have to wait until the next expedition. We have been able to fuse rock standards, so we do anticipate being able to fuse igneous samples without problems and are still planning ICP-AES analysis of any igneous rock samples recovered later in the expedition.

Petrophysics

We measured physical properties on Cores U1499B-2R to 38R for whole-round measurements of magnetic susceptibility (MS), gamma ray attenuation (GRA) density, and natural gamma radiation (NGR), as well as *P*-wave measurements on split core sections using the caliper (PWC). Moisture and density (MAD) measurements on discrete samples were only collected down to Core 29R. As the sediment in the cores became harder, we changed the sampling method, and either cut small pieces or mini-cores for MAD measurements. *P*-wave measurements with the caliper were made on individual core pieces without the liner in Cores 30R to 38R.

We plotted the data and correlated them with the observed lithostratigraphy. Physical properties for Cores 2R to 25R show very little variation. From Core 26R, below about 890 m, physical properties change significantly. From Core 26R to 29R, we observe a general decrease in MS values and NGR counts, whereas the density increases slightly and the *P*-wave velocity increases significantly from 2200 to 2900 m/s. In Cores 30R to 38R, some sandstones show a very high *P*-wave velocity, up to 5360 m/s. In Core 30R, a unique layer of reddish brown claystone with iron-manganese nodules shows high MS values and NGR counts.

Additionally, we continued to use the PWC velocity data from section halves as well as discrete and whole-round density data to produce synthetic seismograms to work toward the correlation of core data with the seismic reflection data.

Education and Outreach

This week the Education and Outreach Officer continued scheduling and planning live video-outreach events, including connection tests before the broadcasts, sending the teachers educational materials about the IODP program and the *JOIDES Resolution*, and conducting post-event surveys. The Education and Outreach Officer started a contest for the schools about the depth at which we will reach the basement in Hole U1500. Routine posting to social media and to the *JOIDES Resolution* blog (http://joidesresolution.org) continued. Some contacts were made with journalists to conduct interviews to help disseminate the expedition research.

Technical Support and HSE Activities

Laboratory Activities

- The beadmaker in the XRD Laboratory is out of service due to failure of the power module. The part has been ordered and beads were being made in Chemistry Laboratory oven.

Application Developer Activities

- Provided exports of RigWatch drilling data in a form consumable by the science party.
- Contributed to current projects: GeoDesc, Coulometer, and XRF data upload.
- Continued testing of LIVE (LIMSpeak replacement).

HSE Activities

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