**IODP Expedition 349: South China Sea Tectonics**

**Week 5 Report (22–28 February 2014)**

## Operations

Week 5 of Expedition 349 (South China Sea Tectonics) began while running in the hole (RIH) with the advanced piston corer (APC) system from 2728.4 m below rig floor (mbrf). After completing the pipe trip to just above the seafloor, we picked up the top drive, spaced out the drill string, and started Hole U1432C at 0555 h on 22 February 2014.

The first coring attempt with the bit at 3835 mbrf did not recover any core. The bit was then lowered to 3838.5 mbrf and the next coring attempt recovered a mudline with 7.95 m of sediment. This was used to calculate the seafloor depth at 3840.1 mbrf (3829.1 mbsl). Non-magnetic core barrels were used for APC coring from Core U1432C-1H through -12H to a final depth of 110.0 mbsf. Temperature measurements (APCT-3) were taken on Cores U1432C-5H, -7H, -9H, and -11H. The hole was terminated when weather conditions improved sufficiently to make it possible to return to Hole U1432B. The bit was tripped to the surface and cleared the rig floor at 0735 h, ending Hole U1432C. Twelve APC cores were taken in Hole U1432C over a 110.0 m interval and recovered 88.74 m (81% recovery). The total time spent on Hole U1432C was 39.25 h.

After returning to Hole U1432B, our next objective was to continue drilling a 22 inch hole for 16 inch casing. Previously, we had drilled a 22 inch hole from the base of the 20 inch casing (57 mbsf) to 160 mbsf before we had to stop due to excessive ship heave. As before, we assembled the underreamer to an 18.5 inch tri-cone bit and bit sub. The underreamer arms were set to open up to a 22 inch diameter. The underreamer and bit were lowered into the moonpool, the top drive picked up, and the underreamer function tested. The top drive was set back and the remainder of the bottom hole assembly (BHA) assembled and RIH to 3828.7 mbrf. During the trip, the subsea camera system was deployed. The bit was spaced out for reentry and Hole U1432B was reentered at 1944 h on 23 February. The camera was pulled back to the surface while the top drive was picked up. The bit and underreamer were lowered to 160.0 mbsf and drilling continued from 4000 mbrf (160.0 mbsf) to 4090.0 mbrf (250.0 mbsf). The depth of Hole U1432B reached 250 mbsf at 0640 h on 24 February. The hole was conditioned and displaced with 379 barrels of 10.5 ppg mud. The drill string was tripped back to the surface and the bit was back on the rig floor at 2120 h. During the trip out of the hole, the rig was secured to slip and cut 115 ft of drilling line.

The drill floor was rigged up to run 16 inch casing. We assembled 240.85 m of 16 inch casing (including casing hanger) and landed it on the moonpool doors with the casing running tool. The casing running tool was released and pulled back up through the rig floor. A 240.77 m long casing stinger was assembled to the bottom of the casing running tool and lowered through the

16 inch casing in the moon pool. The casing running tool with the casing stinger below was latched into the 16 inch casing hanger; two drill collars and a tapered drill collar were assembled above the casing running tool. The entire casing string was lowered to 3827.4 mbrf while filling the drill pipe with water every 20 stands. The camera system was lowered to reenter Hole U1432B. After 15 min of maneuvering the vessel, we reentered Hole U1432B at 0500 h on 26 February. The camera was pulled back to the surface while the top drive was picked up. The casing was lowered into the 22 inch hole and washed down to ~200 mbsf. The camera was lowered again to assist in releasing the casing running tool from the casing. As the camera neared the seafloor, the video feed from the subsea camera was lost. The camera was pulled back to surface for repair (water had intruded the pan and tilt unit causing a power overload in the system) and then lowered back to the seafloor. The casing was washed in to 240.9 mbsf and landed in the reentry cone. The casing running tool was rotated clockwise 3.75 turns which released it from the casing hanger. The BHA including the internal casing stinger was raised up ~11 m and the top drive set back. The cementing assembly was rigged up, the lines were pressure tested, and approximately 20 barrels of cement mixed to 15 ppg was pumped downhole. The cement was displaced with seawater and positioned to balance at the casing shoe to an estimated height of 17 m above the casing shoe (both inside and outside of the casing). The cementing equipment was rigged down and the drill string pulled back to 161.9 mbsf. The circulating head was connected and the drill string flushed with twice the drill string capacity with seawater. The remainder of the drill string was pulled from the hole, clearing the seafloor at 2140 h on 26 February and then clearing the rig floor at 0400 h on 27 February. The BHA components were secured and the running tool was de-torqued.

The next step was to drill a 14.75 inch hole to ~900 mbsf for a 10.75 inch casing string. A new 14.75 inch bit and four stands of drill collars were made up and RIH with drill pipe while filling with water at 20 stand intervals. When the bit was at 3823.3 mbrf, the camera was lowered to allow reentry. Hole U1432B was reentered at 1655 h on 27 February and the camera pulled back to surface. After securing the camera system, the drill string was lowered into the hole until the top of the cement was encountered at 4069.0 mbrf (229 mbsf). The cement was drilled out from 4069.0 mbrf (229.0 mbsf) to 4083.0 mbrf (243.0 mbsf). After washing back to total depth (250.0 mbsf), new 14.75 inch hole was drilled from 4090.0 mbrf (250.0 mbsf) to 4640.0 mbrf (800.0 mbsf). After reaching 800.0 mbsf the hole was swept clean with high viscosity mud. At the end of Week 5, the drill string was being pulled out of the hole prior to installing the 10.75 inch casing.

**Science Results**

Cores from Hole U1432C were described using a combination of visual core description (VCD), microscope inspection of smear slides, core imaging, and scanning for color spectra and magnetic susceptibility. The hole consists of 12 cores (Cores 349-U1432C-1H to -12H) that

penetrated to 110.0 mbsf. The lithology is dominated by a sequence of dark greenish gray clay and clay with silt, assigned to lithotratigraphic Unit I. Clay layers are interbedded with very thin-bedded (centimeter scale) silty layers. These layers mostly fine upward and have sharp erosive bases. These graded sequences are generally 10–20 cm thick and are interpreted as distal turbidites. A 2.4 m thick loose sand occurs in the middle of the hole. The sand and silt layers can usually be identified using magnetic susceptibility measurements, as they typically exhibit lower values than the clays. Thin volcanic ash layers (0.5–2.0 cm thick) occur occasionally in some cores.

The age of the sedimentary sequence recovered in Hole U1432C is <0.91 Ma (Middle–Late Pleistocene) based on planktonic foraminifer and calcareous nannofossil biostratigraphy. Radiolarians are also present throughout the section and comprise a Pleistocene–Holocene assemblage. Nannofossil preservation is moderate to good throughout the hole, with considerable reworking of Pliocene and Miocene species above ~50 mbsf. Preservation of planktonic foraminifers is also moderate to good, with evidence of moderate dissolution as indicated by frequent fragmentation. Planktonic foraminifers are more dominant in sandy intervals that also contain reworked Pliocene species and shallow-water benthic foraminifers. Radiolarians are abundant and moderately to poorly preserved in the upper 15 m of the hole, but become progressively rarer and more poorly preserved downhole.

A total of 16 whole-round samples (5 cm in length) were taken for interstitial water measurements in Hole U1432C. Geochemical analysis shows that sulfate is completely consumed below ~90 mbsf, with methane concentrations increasing significantly, reaching a maximum of ~4750 ppmv below this depth. This sulfate/methane transition zone indicates that the methane at this site is biogenic. Total organic carbon (TOC) in the hole varied from 0.34 to 0.99 wt%, whereas $CaCO_3$ concentrations are generally low (<12%).

Five whole-round samples collected from Hole U1432C were used to inoculate several types of microbiological media to test whether autotrophic and heterotrophic microbes can be grown. For heterotrophic culture enrichments, glucose, acetate, fumarate, and formate were used as sources of carbon and energy. For autotrophic culture enrichments, sodium bicarbonate and hydrogen were used as sources of carbon and energy, respectively. We added a $^{13}C$-labeled carbon source to the media and inoculated approximately 9 g of sample into each serum vial containing the growth media and energy and carbon substrates. Inoculations were conducted in the ship's anaerobic glove box in the cold room and inoculated serum bottles were transferred to a 10ºC incubator. We also collected and preserved 200 ml of drilling fluid containing sepiolite for fluid community tracer analysis. The microbial communities present in these samples will be compared to those present on the inside and outside of the cores to determine whether microbes in the sepiolite behave as suitable contaminant tracers.

As seen at Site U1431, the natural remanent magnetization (NRM) of samples from Hole U1432C contains a vertical component generated by the drilling process, which is easily

removed by 5 to 10 mT AF demagnetization. A polarity reversal at ~105 m is defined as the Brunhes/Matuyama boundary (0.78 Ma). In the Brunhes Chron, there are two directional anomaly intervals at about 10 mbsf and between 50–70 mbsf, respectively. These anomalies could either represent authentic magnetic excursions or be due to post-depositional disturbances.

To further assess the fidelity of the magnetostratigraphic interpretation, magnetic susceptibility curves from Holes U1432C and U1431D are compared using a linear age model defined by the Brunhes/Matuyama boundary. Most major ash layers within this interval correlate between the two sites, which adds confidence that the boundary is correctly placed. These results indicate a higher sedimentation rate (~13.5 cm/k.y.) at Hole U1432C than at U1431D (~5.8 cm/k.y.).

Physical properties measurements made on whole-round core sections were smoothed using a 5-point (10 cm) moving average and combined with discrete sample measurements. The bulk density, *P*-wave velocity, magnetic susceptibility (MS), natural gamma radiation (NGR), thermal conductivity, and shear strength decrease with depth in the top 50 m of Hole 1432C and show an inverse relationship with porosity. Variations in these records are lower below 50 mbsf. This indicates that the compaction effect dominates the physical properties in the top part of Hole U1432C. The 2.5 m thick sand layer near 50 mbsf is clearly delineated by low NGR, low MS, and higher *P*-wave velocity.

Four advanced piston corer temperature tool (APCT-3) downhole temperature measurements on Cores 349-U1432C-5H, -7H, -9H, and -11H indicate a geothermal gradient of 85°C/km. Combining these temperatures with thermal conductivity measurements made on the sediment cores, the preliminary heat flow value at Hole U1432C is 94 $mW/m^2$. This geothermal gradient and heat flow is similar to that at Ocean Drilling Program Site 1148, ~60 km to the NNE.

**Education and Outreach**

We held nine ship-to-shore video events this week with schools and universities in the United States, Spain, China, and the Philippines. We spoke to 171 primary school students in Beijing, China, plus another 104 students in South Carolina during two separate events. We also connected with 20 middle school students in North Carolina, as well as 29 sixth grade students and four teachers in Alaska. We held two events in Spain, one with approximately 50 high school students and another with 46 undergraduates at the University of Salamanca. We also spoke with 15 upper level science majors at Colorado State University and 10 paleontology students at the University of the Philippines. We also connected with a teacher during her poster presentation at the AGU Ocean Sciences meeting in Honolulu, Hawaii. Her poster included *JOIDES Resolution* ship-to-shore events as a way to bring science to life for students, so it was great that we were able to host a live event for approximately 30 minutes during the session!

In addition to ongoing social media and blog posts by the scientists, our TV reporter created two new videos for the Dragon TV evening news in Shanghai, China.

**Technical Support and HSE Activities**

The following technical support activities took place:

Laboratory:

- APC cores from Hole U1432C were processed.
- Fantail:
    - Magnetometer winch controller worked on.
- Cryogenic magnetometer:
    - Drive motor universal joint and shaft repositioned.
    - Haskris bypass regulator pressure set because the unit was bypassing a large amount of cooling water as the regulator bypass pressure was set to low.
- Gas bottle farm pallet stores:
    - Safety pressure relief valve on argon line found capped. Argon safety pressure relief valve set to 150 psi and placed back in service.
- Pallet stores:
    - Area cleaned, all boxes in overhead taken down and cleaned, gas bottles wiped, etc.
    - Inventory taken of supplies in pallet stores.
- Bio cold lab:
    - Glove box gloves replaced and one shelf repaired.
    - Bio gas bottle installed and in use.
- A storeroom inventory is in progress.
- A book inventory is ongoing.

The following HSE activities took place:

- A boat and fire drill was held on 23 February.