IODP Expedition 349: South China Sea Tectonics

Week 4 Report (15–21 February 2014)

Operations

Week 4 of Expedition 349 (South China Sea Tectonics) began while running in the hole (RIH) with the triple combo logging tool string at Hole U1431E. The tool string could only be lowered down to 4715 m below rig floor (mbrf) (463.7 m below seafloor [mbsf]), well short of the total depth of the hole. After logging the upper part of the hole, the tool string was pulled from the hole and rigged down at 0630 h on 15 February. The FMS-sonic tool string was then assembled and RIH at 0855 h. The tool string was lowered into the open hole, but was unable to pass 4661.3 mbrf (410 mbsf). After two logging passes through upper part of the hole, the tool string was pulled from the hole and rigged down at 1915 h on 15 February. The drill string was then tripped out of the hole from 4900.9 mbrf (149.6 mbsf) and cleared the seafloor at 2010 h. While pulling out of the hole (POOH) with the drill string, the starboard conveyor on the pipe racker had a hydraulic failure. The hydraulic block in the derrickman's control booth was repaired, but 1.5 h was recorded as operational downtime. The rest of the trip out of the hole was uneventful and the bit cleared the rig floor at 0555 h. The rig floor was secured for transit at 0600 h on 16 February 2014, ending Site U1431. Hole U1431E was completed in 231.75 h (9.7 d) and Site U1431 was completed in 383.25 h (16.0 d).

At 0600 h on 16 February the vessel started the transit to Site U1432 (SCS-6A). The vessel arrived at the location at 2337 h on 16 February after a 181 nmi transit at an average speed of 10.3 kt. A seafloor positioning beacon was deployed at 2352 h.

The primary objectives at this site require deep penetration coring and logging, so the plan is to install a reentry cone and casing system. The first step was to conduct a jet-in test to determine the length of 20 inch casing that should be attached to the reentry cone. The bottom-hole assembly (BHA) for the jet-in test was then assembled with an 18.5 inch tri-cone bit and run to just above the seafloor. The vessel was offset 20 m south of the original coordinates for Site U1432 when the acoustic beacon landed within 6 m of the coordinates. The subsea camera was deployed to observe the bit tag the seafloor (3840.0 mbrf). After picking up the top drive and spacing out the bit, Hole U1432A was spudded at 1525 h on 17 February. The bit was jetted 62 m into the formation over a 3 h period. The drill string was then pulled clear of the seafloor and the top drive set back. The remainder of the drill string was tripped out of the hole and the bit was back on the rig floor at 0205 h on 18 February, ending Hole U1432A.

Based on the results from the jet-in test, a 5 joint, 57.12 m long, 20 inch casing string was selected. The 20 inch casing shoe joint was cut off to length and a Texas Pattern casing shoe welded on the end of the shoe joint. The remainder of the reentry cone and base were put together, moved into the moonpool, and then positioned underneath the rotary table. The casing

was then run through the rotary table and the reentry cone in the moonpool. Each casing connection was tack welded to prevent the casing from backing out. The casing hanger and a casing pup joint were picked up and attached to the top of the casing string. The casing hanger was picked up with the casing running tool, lowered through the rig floor, through the reentry cone, and the casing hanger landed into the reentry cone. The casing running tool was activated (3.75 turns to the right) to release the casing hanger. A bottom-hole assembly (casing stinger) with an 18.5 inch bit, bit sub, and six drill collars was lowered into the reentry cone and casing. The casing running tool was inserted into this BHA and latched into the casing hanger in the reentry cone. The moonpool doors were opened and the reentry system with the 20 inch casing was lowered through the moonpool and down to 3819 mbrf. The top drive was picked up and spaced out to jet-in the 20 inch casing. Hole U1432B was spudded at 0635 h on 19 February. Jetting continued as the casing was slowly lowered. Seven hours later the reentry system landed on the seafloor. The subsea camera was lowered to observe, and assist in, releasing the casing. After attempting to release the casing for 2.5 h, the casing running tool finally released after the ship was offset from the original position to get the casing running tool to rotate. The rotation required to release the tool was observed clearly on the new subsea camera system. The camera was then pulled back to the surface and secured. The drill string was then tripped back to surface and the BHA set back in the derrick. During the trip out of the hole, the rig was secured to slip and cut 115 ft of drilling line.

An underreamer with an 11.75 inch closed diameter was made up to the 18.5 inch tri-cone bit and bit sub. The underreamer was set to open up the 18.5 inch hole to 22 inches in diameter. The underreamer and bit were lowered into the moonpool, the top drive picked up, and the underreamer function tested. The top drive was then set back and the remainder of the BHA assembled and RIH to 3828.7 mbrf. During the trip, the camera system was deployed. The bit was spaced out for reentry and the vessel positioned using the camera system. Hole U1432B was reentered at 2005 h on 20 February. After reentering the hole, the top drive installed and the drill string washed down to the casing shoe at 57.1 mbsf. After carefully washing down below the casing shoe so that the underreamer was below the base of the 20 inch casing, the pump rate and speed (rotations per minute) increased to drill the 22 inch hole. Drilling continued to 4000.0 mbrf (160.0 mbsf). Drilling was then suspended at 0610 h on 21 February when weather conditions worsened and the high heave of the vessel began to severely affect the weight on bit and underreamer. The bit was tripped back inside the 20 inch casing and the top drive set back. The drill string was then tripped back to the surface, clearing the seafloor at 0835 h on 21 February, and finally clearing the rig floor at 1620 h. The underreamer and bit were inspected and laid out and the BHA racked back into the derrick.

The upper guide horn was then picked up from the drill collar rack and lifted to the rig floor and re-installed below the rotary table. An APC/XCB BHA was then made up while the vessel was being offset 40 m south of Hole U1432B. The drill string was then tripped toward the seafloor and at the end of Week 4 was at 2728.4 mbrf.

Science Results

Most laboratory groups spent the week writing their Site U1431 reports, although some groups continued measurements on remaining discrete samples. The core description group (sedimentologists, petrologists, and structural geologists) finished describing thin sections from Hole U1431E.

The core describers finalized the definition of lithologic units for Site U1431, describing a total of 11 units (nine sedimentary and two igneous). Unit I consists of approximately 100 m of Pleistocene dark greenish gray clay and silty clay. This is underlain by 165 m of Pliocene to lowermost Pleistocene dark greenish gray clay, clay with nannofossils, and silty clay of Unit II. Volcanic ashes are prevalent in Unit I and the upper part of Unit II. Unit III consists of approximately 60 m of Pliocene dark greenish gray clay and light greenish gray nannofossil ooze. Coarser lithologies increase downhole, with Unit IV composed of ~85 m of dark greenish gray clay and silty sand that is latest Miocene to earliest Pliocene in age. Unit V was poorly recovered and likely consists primarily of nearly 200 m of upper Miocene sands. Recovered intervals are composed of dark greenish gray silty sand/sandstone with interbeds of clay with nannofossil ooze. This is underlain by nearly 200 m of middle to upper Miocene greenish black volcaniclastic breccia and sandstone with clay interbeds (Unit VI). Unit VII consists of approximately 90 m of middle Miocene dark greenish gray sandstone, siltstone, and claystone, with the latter often highly burrowed. Unit VIII consists of less than 5 m of dark olive brown to yellowish brown claystone of middle Miocene age found immediately above the basalts. Unit IX comprises ~80 m of basalt representing nine discrete flow units, which is separated from another basalt unit by 10 m of early Miocene yellowish brown claystone with breccia (Unit X). Unit XI consists of ~35 m of basalt from four flows. The basalts of Units IX and XI are generally similar, consisting of sparsely olivine phyric basalts that usually form the tops of the flows, with aphyric crystalline basalts below that grade from fine-grained to coarse-grained in the thickest flow units. Microphenocrysts of olivine, often accompanied by plagioclase and clinopyroxene in the groundmass, suggest a typical mid-ocean ridge basalt crystallization history.

The biostratigraphers analyzed additional samples from lithologic Units VIII and X in Hole U1431E. Radiolarians occur in these claystones, although the poor preservation makes it difficult to identify them confidently. Thus, samples were sieved and specimens from the >63 μm size fraction picked for observation under the scanning electron microscope. Unit X is early Miocene in age (16.7–17.6 Ma) based on the co-occurrence of *Didymocyrtis prismatica and Calocycletta costata*. In the claystones of Unit VIII, a different assemblage of poorly preserved radiolarian species is present, indicating an age younger than 15 Ma (middle Miocene). This is consistent with the presence of the planktonic foraminifer *Orbulina suturalis* (first appearance datum at 15.1 Ma) and a calcareous nannofossil assemblage consistent with an age of 12–13 Ma.

After the remaining sediment and hard rock samples were run for ICP-AES analysis, the instrument was switched over to begin analyzing the pore water samples from Site U1431. The

major and minor element concentrations in the Site U1431 sediments indicate that they are derived from intermediate igneous or quartz-rich sedimentary sources. The basalts recovered from below 900 mbsf in Hole U1431E are mid-ocean ridge tholeiites, whereas the clasts from the volcaniclastic breccias are alkali basalts probably sourced from the nearby seamounts.

The paleomagnetists continued to perform alternating field and thermal demagnetizations on discrete samples taken for shipboard paleomagnetic and physical properties studies. They also determined paleomagnetic core reorientations for several structural features observed by the shipboard structural geologists from the lower part of Hole U1431E.

The physical properties specialists continued measuring discrete hard rock samples from Hole U1431E that require saturation in seawater under vacuum for 24 h before weighing. The *P*-wave velocity was also measured directly on these saturated samples. The variability of the measured values is lower in the deeper units than it was in the volcanic breccias. As expected, the basaltic samples (Units IX and XI) have a much lower porosity and much higher density and *P*-wave velocity than the sandstones and claystones of Unit VII or the volcanic breccias of Unit VI. Measurements of physical properties were not possible in the clay layers close to the basalts (Units VIII and X) because these layers were not indurated enough.

Two downhole logging tool strings were run in Hole U1431E, the triple combo (natural gamma radiation, porosity, density, electrical resistivity, and magnetic susceptibility) and the FMS-sonic (natural gamma radiation, sonic velocity, and electrical resistivity images). The triple combo reached 464 mbsf before a bridge prevented access to the lower part of the borehole. The hole was wider than 17 inches below ~300 mbsf and had closely spaced wide and medium borehole widths above that depth. These were not ideal conditions for borehole log quality; however, stratigraphic changes are apparent in the natural gamma radiation and magnetic susceptibility logs. The FMS-sonic tool string reached only 410 mbsf, with two passes made above that depth. Despite the variable conditions of the borehole, the sonic velocity logs will help to constrain the match to the seismic profiles across the site and turbidite-scale detail is visible in the FMS images. Downhole temperature measurements of the borehole fluid are consistent with the low geothermal gradient established from the APCT3 measurements.

Education and Outreach

We conducted three ship-to-shore video events during the week, speaking with a third grade class in Texas, a geochemistry lab group at the University of Georgia, and over 300 undergraduate students from an introductory oceanography class at Colorado State University. We have had such an enthusiastic response to these events that many of the scientists are now setting up future events with teachers from their hometowns. In addition to the ship-to-shore video events, scientists continue to post blogs on the *JOIDES Resolution* website and personal blog webpages. We also post regular updates on Facebook and Twitter. Our TV reporter made

three compilations of footage for the evening news on Dragon TV in Shanghai, with one highlighting that we had reached our basement objective at the first site.

Technical Support and HSE Activities

The following technical support activities took place:

Laboratory:

- Personal samples were taken for all but the basement sections of Site U1431.
- The core lab is preparing for APC cores from Hole U1432C.
- Fantail:
    - The level wind on the magnetometer winch line was worked on.
    - The seismic sources were tested in preparation for a planned vertical seismic profile.

The following HSE activities took place:

- A boat and fire drill was held on 15 February.
- A security drill was held on 19 February.