IODP Expedition 344: Costa Rica Seismogenesis Project (CRISP-A2)

Week 3 Report (4–10 November 2012)

Operations

Week 3 of Expedition 344 (Costa Rica Seismogenesis Project, Program A Stage 2) continued with efforts to case the upper portion of Hole U1380C. The week began while landing the 10-3/4 inch casing string on the doors to the moon pool. After landing the casing on the doors, we were unable to release the Dril-Quip running tool and pulled the casing back to the rig floor to inspect the running tool. The casing was then re-landed on the moon pool doors, secured and the running tool released. The casing stinger was then made up and spaced out. The running tool and the remainder of the casing bottom-hole assembly (BHA) were made up and the casing was run to just above the seafloor. The subsea camera was run down the casing string. After positioning the vessel for re-entry, Hole U1380C was re-entered at 0745 h on 4 November 2012. The subsea camera was recovered and the casing was run into the hole to 179.27 mbsf, where tight hole conditions were experienced. The casing was pulled back to 150.33 mbsf and the top drive was picked up and installed. Over the next 14 h the casing was slowly worked into the open hole by applying weight while pumping with the top drive. The final depth of the casing shoe was within 18 m of the landing depth when the casing refused to advance any further. The casing eventually became stuck and it required ~120 klbs of overpull to free the casing from the formation. The casing was then pulled back to the surface, clearing the top of the re-entry cone at 0035 h on 5 November. Using the casing elevator, the casing was landed on the moon pool doors at 0110 h. The running tool was released from the casing and we made a decision to try to re-enter the hole with a 9-7/8 inch tri-cone bit and an underreamer assembly to clean out the hole. The idea was to not break down the casing while the hole was being prepared, which would allow us to run the casing quickly after the hole was cleaned to depth.

The 9-7/8 inch bit and the underreamer were picked up and the underreamer was tested in the moon pool prior to deployment. The remainder of the BHA was made up and deployed through the casing string in the moon pool. The casing was picked up with the running tool to deploy the subsea camera. The camera was then run to bottom and the vessel was positioned for re-entry. Hole U1380C was quickly re-entered and the bit was run to just below the bottom of the 16 inch casing. The top drive was picked up and reaming began from 51.4 mbsf. At 216.7 mbsf, at 0045 h on 6 November, the driller experienced erratic drilling torque and then observed the loss of that erratic torque while adjusting his drilling parameters.

A later review of the rig instrumentation data clearly showed not only erratic torque but an increase of weight in the hook load of ~40 klbs. The compensator also stroked all the way open indicating excess weight. The driller reacted by changing his drilling parameters to try to find the cause of the erratic torque. After shutting the pumps down completely the erratic torque vanished completely as did the additional hook load weight. The compensator then stroked back up to its original drilling position. Restarting the pumps again with rotation resulted in not even the reaming torque that was present before the event. At that time the tool pusher and the driller assumed that the underreamer had stopped functioning. The decision was made to pull out of the hole and to inspect the drilling assembly. The bit cleared the re-entry cone at 0229 h and was pulled to the rig floor, clearing the rig floor at 0440 h. The bit and the underreamer appeared intact with no obvious signs of damage. A test of the underreamer failed to energize the arms and we made a decision to pick up the second underreamer and go back to reaming the hole to bottom. The drilling BHA with the new underreamer was picked up and run down to a depth of 371.2 m below the rig floor. At that time the casing hanger was picked up with the running tool to deploy the subsea camera. As the tool pusher began running the camera to bottom, he discovered that the casing string had parted just below the vessel.

We realized that the erratic drilling parameters observed earlier in the day had been caused by the casing string parting and free falling into the hole. The casing re-entered the re-entry cone, made its way down the drill string, and landed on the rotating underreamer arms at 216.7 mbsf. The additional weight of the casing string caused the erratic torque when the casing shoe landed on the rotating underreamer arms. When the driller shut down the mud pumps, the underreamer arms closed and the casing continued its downhole trip.

The subsea camera was run down the drill pipe to survey the possible damage to the re-entry system and casing. The expectation was that the casing would have come to a stop with a portion of the casing extending out from the re-entry cone. The initial underwater survey indicated that the casing had continued its downward journey and that the entire casing string was inside the existing hole. After discussions on board, we decided to re-enter the hole and determine if the hole was salvageable. The vessel was positioned for re-entry and Hole U1380C was re-entered at 1357 h on 6 November. Initially we had planned to pick up the top drive and open the underreamer arms just below the 16 inch casing to determine the top of the casing. The top drive was picked up and the camera was pulled to the surface. Careful observation near the surface indicated that only one complete joint plus the casing hanger (15.24 m total length) remained hanging below the ship. By subtracting that from the full length of the casing string we determined that 390.59 m of casing had landed inside the hole. The only question remaining to be answered was the condition of the casing. It was quickly determined that the top of the 10-3/4 inch casing string was very likely inside the 16 inch casing string. The drill bit was lowered without any significant resistance from inside the 16 inch casing to 336 mbsf. At that point we applied 30–40 klbs weight but no downward progress resulted. After discussions with drilling and science staff, we decided to pull out of the hole and pick up a coring BHA with an RCB bit. The remaining joint of casing and casing hanger were laid out and the BHA was assembled and run to just above the re-entry cone. The subsea camera was deployed and the vessel was positioned for re-entry. The hole was re-entered at 0900 h on 7 November. The bit encountered a possible tag at ~8 m below seafloor, which we interpreted to be the top of the casing. If confirmed, the bottom of the casing should be found at ~398 mbsf; if so, the casing would be covering the problematic zone in the hole. The bit was lowered to 336 mbsf and drilling proceeded carefully from 336 to 438 mbsf without problems. The hole was then circulated clean, the wash barrel was pulled, and an RCB core barrel was dropped. RCB coring commenced at 1745 h on 7 November and continued without interruption to 2400 h on 10 November. The steel RCB core barrels were changed to non-magnetic core barrels with Core U1380C-11R. The only other significant change to coring occurred with Core U1380C-25R. In an effort to improve recovery we started cutting half cores. This dramatically improved core recovery and coring by half cores continued through the end of the week. The depth of the hole at the end of the week reached 787.4 mbsf. A total of 349.4 m was cored and 194.76 m was recovered for a recovery of 56%.

Science Results

Core description was completed through Core U1380C-36R. Down to 553 mbsf (Cores 2R–13R) the lithology is dominated by massive dark-greenish gray clayey siltstone and some centimeter- to decimeter-sized sandy layers that increase periodically in abundance, thickness, and grain size with depth. The first increase of sandstone layers occurs between 470 and 485 mbsf (Cores 5R–6R), the second between 495 and 510 mbsf (Cores 8R–9R), and the third between 548 and 553 mbsf (Core 13R). Individual sandstone beds have generally fining-upward sequences, starting with an erosional contact and centimeter-thick horizons of fine sandstone and transitioning into silty claystone at the top that is often characterized by a moderately to highly bioturbated carbonaceous centimeter-scaled horizon. Shell fragments within the sediments are getting more common toward the base of the hole and ash layers are surprisingly rare. Between 510 and 548 mbsf (Core 10R–13R) large portions of the sediment are highly fractured. At ~554 mbsf (Core 14R) there is a sharp lithologic boundary that is characterized by poorly to weakly consolidated greenish green sand/sandstone with abundant shell fragments and a matrix that is composed of feldspar, amphiboles, chlorite, and lithic fragments. Down to 687 mbsf (Core 30R) the sedimentary sequence gradually returns to a moderately bioturbated, monotonous sequence of very dark greenish gray clayey siltstone with several beds of massive, normal graded, sandstones up to 10 cm thick. Sandstone abundance and grain size are variable but generally increase with depth, as does the occurrence of erosional contacts. The matrix and sandstones contain abundant to dominant, mostly volcanogenic, lithic fragments, common feldspar, glass, rare calcite, chlorite, amphibole, pyroxene, and rare biogenic material that is slightly carbonaceous. Nannofossils are rare but present and foraminifers and diatoms are very rare to absent. A slight change in color in the lower part Core 30R (687 mbsf) marks the transition into a more reddish brownish unit (Core 31R) made out of clayey siltstone interlayered with lithified thick-bedded sandstone to conglomerate layers. After Core 32R (~700 mbsf) to Core 36R the sedimentary sequence returns again to the highly fractured, dark greenish gray clayey siltstone with interlayered 2- to 12-cm thick, normally graded, medium- to fine-grained sandstone beds that sometimes have lamination and enriched laminas of coal fragments. Other biogenic material is absent. Sediments are again composed of common feldspar, glass and mostly volcanogenic lithics, rare amphibole, chlorite, and chert. Until now we have been able to identify 4 to 5 lithologic units, which will be further constrained in the next days.

Micropalaeontology and biostratigraphy work was undertaken on core catcher samples from Hole U1380C. Calcareous nannofossils overall are poorly to moderately preserved with progressively lower abundances downhole. The first appearance of *Discoaster brouweri* constrains the boundary of Zones NN18–NN19 (1.89 Ma) to between Samples 344-U1380C-8R-CC and 9R-CC. The siliceous fraction of 50 core catcher samples was examined and found to be barren. Benthic foraminifers were identified in 22 core catcher samples. Samples were highly indurated leading to longer sample preparation time. The abundance of benthic foraminifers varies widely downhole. Some samples contain a high abundance of well-preserved benthic foraminifers (e.g., Samples 344-U1380-15-CC, 16-CC, and 35-CC) whereas others contain few individuals with diagenetically overprinted signatures.

From Core U1380C-2R to 13R there is a downward gradual increase in deformation structures. Normal faults are present throughout the interval with reverse faults increasing downhole. Deformation culminates in Cores 11R–13R with the development of a pronounced foliation.

Bedding is commonly steeply dipping. Deformation is moderate from Core 14R to 45R and there is no foliation. Bedding remains steep until Core 31R and from Core 32R it is subhorizontal to gently dipping. In the deeper cores there is an increase of discrete brittle shear zones.

We processed and analyzed 25 interstitial water whole-round (WR) samples from Section 344-U1380C-3R-3 to 17R-1 (two of which were dedicated for shore-based He analyses). Section 22R-1 did not yield any fluid after squeezing at 30,000 psi for up to 5 h. Deeper WR samples were collected for shore-based fluid extraction. The pore fluids analyzed show a freshening of chloride to 372 mM, and extend the profile collected at Hole U1380A during Expedition 334 by ~100 m. Potassium and magnesium decrease with depth and are highly depleted in Section 17R-1. Calcium is enriched at depth. The freshening trend indicates contact with a deep fluid source where dehydration reactions released water. Alteration of volcanic material at depth may be responsible for the observed changes in the Ca and Mg concentration profiles.

We collected and analyzed 62 headspace samples for analysis. We detected a high concentration of methane and a small concentration of ethane. Heavy hydrocarbons (C_{3+}) were detected from the top of the cored interval (~452 mbsf) to Core U1380C-13R (~551.9 mbsf).

All Hole U1380C cores have been measured on the WR tracks, and split core measurements have been completed through Core 36R. Changes in many physical properties are observed in Cores 13R–14R (~550 mbsf). Increases are observed in magnetic susceptibility, bulk density, strength, and *P*-wave velocity, whereas natural gamma ray and porosity values decrease. Magnetic susceptibility values are variable until Core 31R and low Cores 32R–47R.

The behavior of the natural remanent magnetization (NRM) has been relatively uniform at Hole U1380C. The mean NRM intensity is ~10^{-3} A/m and exhibits no significant variations downhole. Declination values are relatively stable during demagnetization. Some core sections exhibit highly persistent declinations (0 or 360 degrees). Work is ongoing on the corresponding discrete samples to investigate the origin of this declination phenomenon. Both normal and reversed polarities have been observed but the data so far are insufficient to confidently define magnetic polarities.

Education and Outreach

Blogs and photos were added to joidesresolution.org, Facebook, Twitter, and Tumblr. Several foreign language blogs were added for Brazilian, German and Japanese audiences. Interviews continued for video production as did work on plate tectonics animations.

Technical Support and HSE Activities

The following technical support activities took place:

- Labs processing core
- Fume hood alarm replaced on forward Chemistry lab fume hood
- Carver press pressure setting dial worked on by Electronics Technicians

- Marine Lab Specialists given Protected Species Observer (PSO) presentation
- Pre-Seismic Operations meeting held on November 10 to discuss PSO procedures

The following HSE activities took place:

- Vessel fire and boat drill was held on Friday, November 10
- Eyewash stations tested
- Lab Safety email sent to scientific participants reminding them of need to use safety glasses and closed shoes when on the catwalk and in laboratories. Also to use eye protection when using the rock saws and drill press to cut samples.