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

Week 6 Report (25 November–1 December 2012)

Operations

Week 6 of Expedition 344 (Costa Rica Seismogenesis Project, Program A Stage 2) began with the recovery of Core U1413A-10H at 79.5 m below seafloor (mbsf). Coring continued through Core U1413A-26X to 189.1 mbsf. Because of the slow coring rate, the decision was made to pull out of the hole and change coring systems to the RCB system. At Hole U1413A, 18 APC cores were taken over a 140.6 m interval with 143.6 m recovered (102%), and 8 XCB cores were taken over a 48.5 m interval with 43.7 m recovered (90%). The overall recovery for Hole U1413A was 187.3 m over the 189.1 meters cored (99%). Hole U1413A ended when the bit cleared the seafloor at 2355 h on 25 November 2012. The total time spent on Hole U1413A was 48.5 h.

Next, a shallow hole was cored for geochemical analyses. The vessel was offset 20 m to the east and Hole U1413B (8°44.4593'N, 84°6.7992'W) was spudded at 0055 h on 26 November. The seafloor depth was established at 540 m based on the mudline core recovery. Three APC cores were taken over a 25.6 m interval with 27.4 m recovered (107%). Non-magnetic core barrels were used but orientation was not recorded. The bit cleared the rotary table at 0550 h on 26 November, ending Hole U1413B. The total time spent on Hole U1413B was 5.75 h.

After offsetting the vessel 20 m south, an RCB bottom-hole assembly (BHA) with a new 9-7/8 inch bit was made up and run in the hole to just above the seafloor. Hole U1413C (8°44.4482'N, 84°6.7993'W) was spudded at 0940 h on 26 November. The seafloor depth was assumed to be 540 m based on Hole U1413B. Drilling without recovery continued for 11.75 h and reached a depth of 178.0 mbsf. A non-magnetic RCB core barrel was dropped and coring began. Coring continued with Cores U1413C-2R to 43R to a total depth of 582.2 mbsf, which was reached at 1300 h on 29 November. Forty-two RCB cores were taken over a 404.2 m interval and recovered 313.9 m (77.7%).

After completing coring, the hole was swept clean with a 50-barrel high-viscosity mud sweep. A wiper trip was made from bottom to 88.4 mbsf. On the way back into the hole, we ran into an obstruction at 250.6 mbsf. The hole had to be washed and reamed down to the total depth of 582.2 mbsf. Another 30-barrel high-viscosity mud sweep was pumped, followed by a 50-barrel sweep. The RCB bit was released at 572.2 mbsf and the hole was displaced with heavy mud in preparation for logging. The drill string was pulled out of the hole so that the end of the pipe was set at 103 mbsf. Because hole conditions were poor, the decision was made to not run the nuclear source on the first logging run. The logging tools were rigged up and the triple combo tool string was run into the hole at 1200 h, reaching a total depth of 181.9 mbsf. The next logging run was with the Ultrasonic Borehole Imager (UBI) tool string. This run started at 1600 h and reached 189.9 mbsf. The final logging run was with the Formation MicroScanner (FMS) tool string. The run started at 1955 h and reached the same depth of 189.9 mbsf. The logging tools were rigged down and the rig floor was secured for transit to Site U1412 at 0145 h on 1 December. The total time spent on Hole U1413C was 116 h. The total time spent on Site U1413 was 170.25 h or 7.1 days.

The vessel returned to Site U1412 after a 15.0-nmi transit completed in 1.75 h. The vessel stabilized over Hole U1412D at 0330 h on 1 December and an acoustic beacon was deployed at 0418 h. An RCB BHA with a used 9-7/8 inch bit was made up and lowered just above the seafloor. Hole U1412D was spudded at 0850 h on 1 December at a water depth of 1973.0 m. Drilling without recovery continued for 15.25 h and reached a depth of 272.8 mbsf by the end of the week.

Science Results

Three lithological units have been identified in the 579 m recovered at Holes U1413A, U1413B, and U1413C. Unit I is 44.6 m thick and is dominated in both Holes U1413A and U1413B by dark greenish gray silty clay with abundant centimeter-thick sequences of millimeter-thick, turbiditic, fine-sand laminae and one slumping event in the uppermost core. In the lowermost part of Core U1413A-5H the lithology changes first into a brownish green chaotic mixture of silty clay with dark gray sands, representing another slumping event. Unit II is characterized by light greenish gray calcareous clayey silt/siltstone, with some smaller variations in grain size to silty clay and minor sand/stone layers. In the following cores, this well-consolidated monotonous lithology shows varying amounts of calcareous cementation with depth. In Section U1413A-20X-1, another chaotic layer of intermixed sand and calcareous clayey silt occurs that is not associated with a lithologic boundary but probably represents a slide/slump interface. Unit II continues in Hole U1413C until 366.5 mbsf. The Unit II/III boundary (Section U1413C-21R-3, 117 cm) is indicated by the first appearance of an 18 m thick package of alternating sand and siltstone that includes common to abundant wood, shell, and gastropod fragments. The matrix of the siltstones and sandstones is characterized by abundant magmatic and sedimentary lithic fragments as well as the common occurrence of feldspar, foraminifers, glass fragments, rare to common amphibole, chlorite, and glauconite as well as accessory pyroxene. After a short interval (42 m) of siltstones the sediments of Hole U1413C (426.8-578.8 mbsf) are dominated by massive, meter- and decimeter-thick, slightly normally graded, fine- to medium-grained sandstones. The lithologic units correlate well with the Site U1379 units identified during Expedition 334.

Paleontological and biostratigraphic work was finished at Site U1413. Biostratigraphy was constrained by radiolarians and nannofossils, which are present throughout Holes U1412B and U1413C. Radiolarians are present in the upper cores of Hole U1413A but are not present starting with Core U1413A-10H. Nannofossils are present throughout the section, although they become increasingly rare towards the bottom of Hole U1413C.

Calcareous nannofossil assemblages constrain the upper portion of Hole U1413A to Zone NN21. A change in assemblage is present between Samples 344-U1413A-19X-CC and 10X-CC with the first appearance of *Pseudoemiliania lacunosa*. Nannofossil biostratigraphy indicates that the base of Site U1413 is Zone NN19.

Foraminiferal work of Site 1413 has been finished with 25 samples studied in Hole U1413A and 24 in Hole U1413C. Benthic foraminifers are “abundant” to “common” throughout and preservation is “good” from Sample U1413C-2R-CC to 17R-CC. Abundance and preservation decreases downhole from Sample U1413A-19X-CC to the bottom of Hole U1413A. Preservation is moderate in Hole U1413C where foraminifers show signs of mechanical breakdown. Benthic foraminiferal species abundances fluctuate dramatically downhole, with some species

dominating the benthic assemblage, such as *Brizalina bicostata* (80% of the assemblage between Samples U1413A-14R-CC and 19X-CC) and *Uvigerina peregrina* (80% of the assemblage between Samples 344-U1413C-36R-CC and 42R-CC).

Faulting related deformation increases with depth at Site U1413. Deformation is additionally localized along brecciated fault zones at 181, 230, 237–239, 365, 529–532, and 567 mbsf. Both normal and reverse faults are observed. Dip angles of the faults vary from subhorizontal to subvertical. The deeper part, starting with Core U1413C-21R, is additionally characterized by reverse faults with extremely steep dip angles (>75°).

We completed the chemical analyses for 106 interstitial water samples collected from Site U1413. Hole U1413B was dedicated to high-resolution sampling for studies of the biogeochemical processes just below the sulfate-methane transition zone (SMTZ), which at this site occurs at 16 mbsf. The pore fluid profiles of sulfate, alkalinity, and ammonium concentrations in the uppermost ~150 m reflect characteristic organic matter remineralization that is impacted by sediment slumps at ~45 and ~150 mbsf. Calcium and magnesium concentrations decrease from seawater values at the seafloor to minima of 1.1 and 39.8 mM, respectively, at the Unit I/II lithologic boundary, reflecting precipitation of authigenic carbonates. The Cl concentrations decrease with depth to ~500 mbsf, and below this depth the Cl profile shows a trend of increasing concentrations to ~96% seawater value. The reason for the lower than modern seawater Cl values throughout most of this site, but in particular in the upper ~150 m, is as yet unclear.

Methane increases below the SMTZ and the C_1/C_2 ratio in the upper 50 m indicates a biogenic origin for this gas. Below this depth, the C_1/C_2 ratio decreases steadily with depth, and shows a marked decrease to values <100 below 480 mbsf, indicating a thermogenic component at depth.

All Site U1413 physical properties measurements were completed, with the exception of a few moisture and density measurements. Porosity data show more gradual compaction in Hole U1413C than in the upper section of Site U1413. Thermal conductivity and *P*-wave velocity values are stable to slightly increasing with depth. Magnetic susceptibility values are variable, with some very high spikes, in Hole U1413A and lower and less variable in Hole U1413C. NGR values generally increase from the seafloor to 180 mbsf and then gradually decrease with depth.

The entire week was spent measuring the remanent magnetization of almost all archive section halves from Site U1413. Preliminary pass-through data show that many intervals are reversely magnetized, suggesting these sediments were probably magnetized within the Matuyama reversed chron.

Hole U1413C was logged on 30 November. Because of a borehole obstruction, we were unable to reach total depth and could only log from 94 to 187 mbsf in the open hole. The measurements included borehole diameter, electrical resistivity, total and spectral gamma ray, and ultrasonic and resistivity images of the borehole wall. The image data show an interval of well-developed borehole breakouts (94–148 mbsf) that mark the direction of the minimum horizontal stress in the upper plate.

Education and Outreach

Blogs and photos were added to joidesresolution.org, Facebook, and Twitter. Eight video conferences were held with elementary school students in Lakeside, California; middle school students in Kentwood, Michigan, and Los Angeles, California; and high school students in Mechanicsville, Virginia, New Point Richey, Florida, and Lakeside, California. A 3-way videoconference was held with students at the University of Chiba, Japan, and Expedition 338 scientists on the *Chikyu.* CRISP-2 Episode 1 describing the scientific objectives of the expedition was released on YouTube: https://www.youtube.com/watch?v=SLreP3TuwBg&feature=plcp

Technical Support and HSE Activities

The following technical support activities took place:

- Labs processing core

The following HSE activities took place:

- Vessel boat and security drill held on Wednesday, 28 November
- Eyewash stations tested