IODP Expedition 354: Bengal Fan

Week 6 Report (1–7 March 2015)

This week we continued RCB coring in Hole U1451B. Cores 21R to 73R sampled 476.7 m of formation (704.6–1181.3 m) and recovered 150.28 m of core (32%). Due to the nature of the rocks being recovered at the base of Hole U1451B, we decided to stop further coring on 6 March. Wireline logging was not attempted due to poor hole conditions. At the end of the week, we returned to Site U1450 to conduct deep RCB coring and wireline logging.

Operations

Hole U1451B (MBF-3A)

Cores U1451B-21R to 36R penetrated 155.6 m (704.6–860.2 m) and recovered 37.98 m of core (24%). The drill string became stuck after retrieving Core 35R and 30 min were needed to work the pipe free. Due to the poor hole conditions, we decided to conduct a wiper trip after Core 36R arrived on the rig floor. While raising the bit back up into the 10.75 inch casing that extends to 401 m, the drill string encountered significant torque and up to 30–40 klbs of drag. After slipping and cutting the drill line with the bit inside the casing, the bit was lowered to 637 m where it encountered a bridge. We washed and reamed from this depth back down to the bottom of the hole (860.2 m) and resumed RCB coring at 0145 h on 3 March. After a few fast penetration, low recovery cores (Cores 38R–41R; presumably loose sands) with high drill string torque and some overpull, we conducted a short wiper trip by raising the bit from 908.9 m up to 869.6 m and then washing back to bottom. RCB coring resumed at 1115 h on 3 March.

Cores 42R to 73R cored from 908.9 to 1181.3 m (272.4 m) and recovered 104.28 m of core (38%). Due to the nature of the rocks being recovered, we decided to stop further coring at 1440 h on 6 March and conduct wireline logging. We started to raise the bit back up to the base of the 10.75 inch casing (401 m), two joints of drill pipe at a time (doubles) and with the top drive in place, because of the poor hole conditions. While raising the bit, the drill string experienced torque and overpull and then became stuck at 963 m. We also observed up to 250 psi of overpressure in the drill pipe. After the drill string was freed, we had to rotate, apply overpull, and circulate to be able to raise the bit up to 529 m. We then removed the top drive, but still had 20–25 klbs of overpull until the bit was up inside the casing. Based on the hole conditions, we decided it was not reasonable to log the hole. At the end of 6 March, we started reassembling the drill pipe doubles back into stands so that we could resume recovery of the drill string. After the bit was back on board, the rig floor was secured, the seafloor positioning beacon was recovered, and we departed for Site U1450 at 0806 h on 7 March.

Site U1450, Hole U1450B

After a 64 nmi transit, we arrived back at Site U1450 at 1342 h on 7 March. We assembled an RCB with a mechanical bit release (MBR), lowered it to the seafloor, and started drilling in Hole U1450B at 2305 h on 7 March. We plan to drill without coring to 600 m (Hole U1450A cored to 687.4 m), core below that depth, and then log.

Schlumberger wireline logging activities:

- Checked seismic source (surface solenoid check without air pressure) to confirm compatibility and functionality prior to logging Hole U1451B.
- Held several meetings with Co-chiefs, rig-side IODP management, and EPM to discuss logging options and scenarios.
- Prepared software and equipment for logging in Hole U1451B with expected logging on Saturday/Sunday; ultimately cancelled due to hole conditions.
- Rechecked existing software and equipment preparations for upcoming Hole U1450B logging.

Science Results

Overview

Site U1451, the easternmost location of the 8°N transect drilled by Expedition 354, is our deepest targeted drilling depth down to a seismic unconformity, which is believed to indicate the onset of fan deposition at this latitude. This site also contributes to the Miocene–Pliocene transect of three 900 m deep holes and the Pleistocene coverage at six locations. In addition to the overall Neogene deposition objective, this site is intended to extend back in time the sedimentary record of the Himalayan erosion.

Lithostratigraphy

The drilling of Hole U1451B that we initiated last week was completed on 6 March at a total depth of 1181.3 m DSF, with 28% recovery of the cored interval. Relatively soft silty clay, silts and calcareous oozes gave way downhole to increasingly lithified intervals of claystone and siltstone rich in plant fragments. At ~860 m CSF-A, recovered cores contained bioturbated limestones alternating with laminated mottled claystones and siltstones with plant fragments, indicating a transition from a turbidite-dominated to a carbonate-rich and/or clay-rich depositional environment. From 1103.4 m CSF-A to the bottom of the hole, recovered material is predominantly heavily bioturbated and mottled marlstones alternating with light gray to white limestone with occasional intervals of claystone. Siltstones still occur in this interval, though they are well-sorted, do not exhibit sedimentary layering, have a much reduced mica content compared to the siltstones higher in the section, lack plant debris, exhibit fluid escape features,

and occasionally contain clasts of the carbonate rocks. These siltstones appear to be post-depositional features that have been injected into the carbonate sequences.

Biostratigraphy

This week, calcareous nannofossil and foraminiferal biostratigraphic analyses were conducted on both core catcher and core samples from Hole U1451B. We analyzed ~120 samples for nannofossil assemblages and ~75 samples for foraminifera. Foraminifera were rare, and over 50% of samples were barren. When present, foraminifera were frequently recrystallized or flattened, making identification difficult. Foraminifera from the early Miocene to latest Eocene were found in samples consistent with nannofossil assemblages. Nannofossil biostratigraphy places the deepest clear turbidite deposits (1093 m CSF-A) to the Upper Oligocene, and the bottom of Hole U1451B to the Upper Eocene.

Paleomagnetics

We completed preliminary paleomagnetic studies at Hole U1451B on all retrieved cores (Cores 1X to 65R). We measured the archive section halves at four alternating field demagnetization steps (0, 10, 15, and 20 mT) to evaluate the downhole changes of the remanence magnetization behavior during AF demagnetization as well as changes of the magnetic polarity. None of these cores were oriented, and noise and bias made it difficult to identify magnetic polarity from inclination alone. We did observe sedimentary bedding that appears to have been tilted perhaps by local faulting; in the seismic data reflectors appear to dip to the east. In the cores, we measured the apparent dip of the formation on the split surface of all archive section halves. Using the magnetic declination measured at the same points as the apparent dip measurements, we were able to calculate a best-fit true dip, and to use changes in the direction of our dip estimate to evaluate the magnetic polarity for most cores. We also refined our analysis of the magnetostratigraphy obtained at Hole U1451A in conjunction with the biostratigraphy. We were able to confidently identify eight reversals over the last 5 Ma. The sedimentation rate in the hemipelagic sequences is on the order of 1.5 cm/k.y. This value is similar to sedimentation rates determined for sections of comparable age at Sites U1449 and U1451.

Physical Properties

Physical property data were acquired on cores from Hole U1451B, including density, magnetic susceptibility, *P*-wave velocity, natural gamma radiation, and thermal conductivity. Measurements with the WRMSL became increasingly difficult because the liners were no longer completely filled with sediment due to RCB drilling. As a consequence, the PWL was turned off and we increased the amount of *P*-wave measurements made on the split cores with the caliper. Also, we are exploring ways to compensate for the incompletely filled cores to correct GRA values in the lower part of the hole.

The physical properties in Hole U1451B, between 540 to 1180 mbsf, reflect both lithological variations and lithification with depth. *P*-wave velocities and bulk densities had a gently increasing trend with depth from 540 to 950 mbsf, due to compaction and lithification. Calcareous lithologies lithified at shallower depths than the other litholologies, as reflected in the *P*-wave velocity measurements, reaching over 3000 m/s in limestones at 950 mbsf. Pelagic limestones between 1110 and 1160 mbsf had *P*-wave velocities between 2700 to 3500 m/s, and the limestones beneath reached 5000 m/s.

Geochemistry

The chemistry laboratory spent the week processing and analyzing samples from Holes U1451A and U1451B for pore water and bulk sediment geochemistry. Headspace gases in Hole U1451B revealed remarkably low concentrations of methane (<8.5 ppmv) down to the bottom of the hole. Analysis of interstitial waters for alkalinity, chlorinity, pH, major elements, and anion chemistry are in progress for Hole U1451B. Bulk sediment geochemistry characterization by ICP has been completed for Hole U1451A (36 samples) and is in progress for Hole U1451B. Analyses for total inorganic carbon (TIC) and total carbon (TC) are complete in Hole U1451A (81 samples) and in progress for Hole U1451B (25 samples). Carbonate content in Hole U1451B varies from 2 to 87 wt%. Total organic carbon (TOC) calculated by difference between TC and TIC varies from <0.1 to 1.1 wt%. Handheld XRF measurements are being performed on selected sections of cores from the lower part of Hole U1451B to supplement data collected from bulk chemical and physical properties analysis. These data allowed non-destructive, fast and effective estimates of clay to carbonate ratios in non-turbiditic sediments.

Summary

Operations in Hole U1451B allowed core to be recovered down to the Eocene in spite of very difficult hole conditions. Bellow the 400 m deep casing, loose sand formation collapse required very efficient coring operations, minimizing time without water-mud circulation and rotation of the drill string. This allowed total penetration down to 1181.3 m CSF-A with excellent recovery in the deeper section of the hole. Overall, Hole U1451B extended the turbiditic record of the Himalayan erosion to the Upper Oligocene (25–28 Ma), a time interval not documented elsewhere. Hole U1451B records the timing of fan onlap at this site and marks the transition to clay rich and/or pelagic carbonate deposition throughout Oligocene and Eocene. The clear seismic reflector previously reported as an Eocene unconformity seems to fit with the onlap of the fan over lithified limestone and claystone during the Upper Oligocene. The Eocene and Lower Oligocene sequence has undergone significant post-depositional deformation marked by silt injections in the limestones and claystones on various scales. The depositional nature and origin of the clay-rich sequences remains to be elucidated. This type of deposition does not correlate with equivalent deposition during Oligocene at Site 758 on the Ninetyeast Ridge. While one could have expected older fan onlap at this site and provide a longer record of direct Himalayan erosion, the achieved coring reached completely the objectives and extended back in

time this record as far as possible within reasonable drilling depth. The deeper limestone-claystone will further document the Oligocene–Eocene evolution of the Bengal basin.

Education and Outreach Activities

As part of our Education and Outreach activities for the Bengal Fan Expedition, we posted daily updates and photos on our official social media outlets (Facebook [https://www.facebook.com/joidesresolution], Twitter [https://twitter.com/TheJR], and Instagram [http://instagram.com/joides_resolution]). We selected a winner of the contest to boost the number of Instagram followers, which have increased by >40% since the start of the expedition. We continued compiling activity metrics from these websites, and are using these analytics to improve posts and increase our reach. We also wrote blogs for the http://joidesresolution.org/ website.

To prepare for our live video interactions with schools and museums around the world, we continued to communicate with shore-based educators to schedule broadcasts and carried out several test connections. We held live broadcasts with Lewisville High School (Lewisville, TX), University of Washington (Tacoma, WA), University of British Columbia (Canada), Telopea Park School (Australia), Lycée Pablo Picasso (France), Lycée Lucie Aubrac (France), IES Severo Ochoa de Granada (Spain) and Lycée Franco-Bolivien (Bolivia), plus two "ship chats" with the Exploratorium (San Francisco, CA). Of particular note was a live broadcast with Tribhuvan University (Nepal), which was a significant achievement given the remote location, and a unique opportunity to connect with students in the Himalayas—the source of the sediments in the Bengal Fan. We also held a live broadcast with the "Unterirdisch" Geo-Show, part of the annual IODP/ICDP science meeting in Germany, which was attended by over 500 students and hailed as the highlight of the show by the local newspaper. Lastly, we organized two "Friends & Family" broadcasts for members of the Science Party.

We interviewed scientists for and edited the "Source to Sink" video in final post-production. We shot beauty slider video of core from deep in Hole U1451B. A scientist and IODP technician have built a tank with a slope to demonstrate turbidity currents. We started pre-production and testing of this turbidite demonstration video, and possibly plan to film a "making of" video, interviewing the two developers. The Education Officers had a halfway point check-in with the Assistant Director of Education at the Consortium for Ocean Leadership.

Technical Support

Technical staff were still fully engaged supporting coring and science operations at Site U1451. Laboratories were fully operational, although we had to work through several issues to avoid any major impact to the science operations.

Laboratory Activities

- **SRA (Source Rock Analyzer):** We began systematic troubleshooting efforts to understand why the SRA is not functioning.
- **Liquid Nitrogen Generator:** We are in the process of implementing vendor recommended actions to clear the Liquid N_2 generator of ice and zero the fill gauge.

Developer Activities

- **DescLogic (Core Description Application):** Since the release of version 10, we have had an apparent increase in the frequency of application crashes. The cause is under investigation and we may roll back to the earlier version.
- ***P*-wave Logger (Whole Round Multisensor Logger):** Fixed issue with the 20 MHz filter and updated the user interface to display the threshold and time pick in real time.

MCS Activities

- **Logging Data:** A test was successfully completed transmitting logging data to LDEO.
- **SHIL-b (Imaging Track Computer):** Removed the solid state drive because of recurring issues with the RAID controller. Working with the LSI vendor on a firmware upgrade to the controller.

HSE Activities

- The weekly fire and abandon ship drill was held.