IODP Expedition 355: Arabian Sea Monsoon

Week 5 Report (26 April–2 May 2015)

Operations

Hole U1456D (IND-03C)

Rotary core barrel (RCB) coring continued without incident through Core U1456D-43R to 866.2 m below seafloor (mbsf). Hole conditioning consisted of pumping 40-barrel sea gel mud sweeps every third core. While cutting Core 44R, the driller noted erratic changes in pump pressure and excessive torque. After pumping a 40-barrel mud sweep, the core barrel landed with a 200 psi pressure loss. After advancing 2.0 m the lost pressure was regained; however, after advancing another 1.0 m the hole apparently began to collapse around the drill string. Pump pressure increased by 600 psi, top drive torque increased by 200 A, and there was a 20,000 lb weight loss. We spent 2.25 h circulating and working the pipe back to 821.0 mbsf. We then recovered Core 44R and completed a wiper trip to just inside the 10¾ inch casing shoe at 442.6 mbsf. The wiper trip was uneventful, with no apparent issues with the upper portion of the hole. After taking a short period of time to service the rig and grease the traveling block, the pipe was tripped back in the hole. The pipe was lowered to 821.0 mbsf, with the driller noting 10,000 to 15,000 lb of drag from 722.0 to 753.0 mbsf. We picked up the top drive at 0930 h on 27 April and after beginning circulation we noted a 400 psi pump pressure excess, indicating that the annulus of the hole was filled with drill cuttings. We pulled the pipe back to 791.9 mbsf and deployed a wash barrel. At 1100 h the pipe washed/reamed back to the original total depth (TD) of 869.2 mbsf, encountering 12 m of fill at the bottom of the hole. We circulated a 50-barrel sea gel mud sweep and then spent an additional 2.5 h circulating a series of mud sweeps (two 50-barrel sweeps at 110 viscosity, a 50-barrel sweep at 120 viscosity, and a 60-barrel sweep at 130 viscosity) before regaining normal drilling parameters.

With the hole stabilized, we recovered the wash barrel and deployed a RCB core barrel. At 1830 h on 27 April, RCB coring recommenced. As a preventative measure, the drillers pumped 50-barrel high-viscosity mud sweeps every other core to help prevent any recurrence of cuttings build-up in the hole annulus. Coring continued without incident through Core U1456D-54R to 966.2 mbsf. While cutting Core 55R, an abrupt change in the rate of penetration (ROP) occurred at ~970 mbsf. The ROP dropped to 2.9 m/h. We recovered Core 55R after only a 6.0 m advance and found that the core barrel had been jammed, resulting in poor recovery (3%). We recovered Core 56R after a 6.0 m advance (125 min at 2.9 m/h) due to concerns that the barrel may have jammed again; however, the core barrel was full (111% recovery) and the slow ROP was due to the hard sandstone lithology. We picked up a knobby drilling joint for cutting Core 57R to 987.4 mbsf. This 9.2 m advance required 270 min of rotating time (2.0 m/h). At this point hole conditions became problematic with high torque (600 A) and pump pressure elevated by 400 psi. We spent more than 8 h working the pipe, circulating multiple 50-barrel high-viscosity mud sweeps, and conditioning the hole before coring could resume. At 1830 h on 29 April, we

resumed coring. Core 58R was cut to 996.6 mbsf (9.2 m advance) in 160 min at 3.5 m/h. After recovering this core and deploying the next core barrel, hole conditions again deteriorated. Top drive torque increased and when the core barrel landed, the driller noted that he had lost the ability to rotate the pipe. The pipe was freed in less than 1 h; however, this required 900 A of top drive torque and 55,000 lb of overpull. Core 59R was cut to 1005.8 mbsf with a slightly higher ROP. Coring continued through Core 61R to a depth of 1024.4 mbsf at an average ROP of 6.0 m/h. Because of the accumulated bit rotating hours plus the intangible unrecorded reaming hours, we decided to cut one additional core and then round trip the drill string for a bit change. When the core barrel landed for the final core, the WKM valve on the top drive failed and would not seal properly. Since replacing the valve required tripping the pipe up inside the casing shoe at 455 mbsf, we decided instead to recover the entire drill string to change the bit and also repair the WKM valve.

We displaced the hole with heavy mud, recovered the empty core barrel, and the drill string was pulled clear of the seafloor at 1900 h on 30 April. We offset the vessel 50 m from the reentry cone, serviced the rig, and removed the WKM valve to expedite the required repairs. The drill string was recovered back to the surface with the bit clearing the rotary table at 0355 h on 1 May. We checked all outer core barrel subs, inspected the RCB latch sleeve, and prepared a new CC-4 RCB bit. The bottom-hole assembly (BHA) was reassembled and by 1045 h the drill string was deployed to a depth of 3274.4 m below rig floor (mbrf) when the 5½ inch pipe racker developed a problem. We spent 45 min troubleshooting and fixing the pipe racker. The pipe trip resumed to 3624 mbrf and then the subsea camera was deployed and lowered toward the seafloor for reentry. While the camera was being deployed, the spare WKM valve was installed on the top drive in preparation for coring operations. We began maneuvering the ship at 1440 h on 1 May and reentered Hole U1456D in 35 min. We recovered the subsea camera to the ship, and continued tripping the pipe inside the 10¾ inch casing to 442.6 mbsf where we encountered unexpected resistance. We pulled back the pipe, deployed a wash barrel, and picked up the top drive. Using very slow rotation and minimal pump pressure, the bit was lowered through the obstructed area with no discernable indication of resistance. We lowered the drill string below the casing shoe to 529.9 mbsf, recovered the wash barrel, and racked back the top drive.

We continued to lower the drill string without incident to a tag depth of 995.8 mbsf with a maximum drag of 10,000 lb. We picked up the drill string to 966.6 mbsf and picked up the top drive. At 0100 h on 2 May, the driller attempted to break circulation and realized that he could not rotate the string or circulate fluid. The driller picked up the drill string to 937.5 mbsf with no overpull. We picked up a knobby joint and the top drive and worked the drill string for 2.75 h. Circulation was reestablished; however, 900 A of maximum torque and 150,000 lb of overpull failed to free the drill string. At 0600 h on 2 May, we offset the ship 185 m (5% of water depth) to the south to set a drill pipe tool joint at the rig floor. The sinker bars were installed with a core barrel attached and this assembly was lowered into the drill string to determine if there were any mechanical issues with the integrity of the drill string or if hole instability and stuck pipe was the sole issue. The core barrel would not pass a depth approximately equal to the seafloor depth

(hard tag at ~3668 mbrf), indicating that there were other issues in addition to hole conditions. The vessel was offset to allow recovery of the wireline assembly, the upper guide horn was pulled, and the subsea camera was deployed to determine if there was a problem at the seafloor. The subsea camera showed that the reentry cone was buried in cuttings; however, the drill pipe appeared to be extending straight up from the reentry cone/cuttings pile. We observed no identifiable problem with the drill pipe or the seafloor installation. We recovered the subsea camera on deck at 1240 h on 2 May.

At this point we decided to sever the drill string and abandon Hole U1456D. We hoped to sever in the first joint of 5½ inch drill pipe (transition joint) above the tapered drill collar (TDC) at the top of the BHA; however, there was some concern that (1) the wireline severing tool may not be able to pass the seafloor and (2) if the pipe was severed above the BHA the drill pipe above may still remain firmly stuck in the hole. We held a safety meeting at the rig floor and preparations began for rigging up the Schlumberger wireline drill pipe severing tool. After securing radio silence and shutting down all wireless devices, the severing tool was deployed at 1800 h on 2 May. There was no problem passing through the transition zone at the seafloor and the tools reached all the way to the bit. The system was then recovered back and positioned at the approximate mid-point (~4.5 m) of the first joint of 5½ inch drill pipe above the TDC. We applied a slight amount of torque and overpull to the drill string before the charge was fired; however, no voltage was sent. The Schlumberger computer used to control the system was rebooted and the second attempt to fire the charge was successful. The driller was then able to pull the drill string back to the next tool joint and rotate, indicating that the string was successfully severed at the location desired and freed from the formation. As of 2400 h on 2 May, the severing tool was being recovered back to the ship and planning had begun for drill-in casing/reentry cone operations for Hole U1456E.

Hole U1456D consisted of 60 RCB cores recovering 319.18 m of core over 656.6 m of penetration (57% recovery). Including the initial drilled interval, the total depth of the hole was 1024.4 mbsf.

Science Results

The sedimentologists described Cores U1456D-31R through 61R (740.1–1018.56 mbsf) using a combination of visual core description, microscopic investigation of smear slides, core imaging, spectral color scanning, and magnetic susceptibility. The dominant lithologies in Cores 31R through 40R are dark greenish gray nannofossil-rich claystone and dark gray claystone, with bioturbation and pyrite nodules. Drilling disturbance is often moderate, and biscuit and brecciated features are common. The dominant lithologies change in Cores 41R through 44R to light green nannofossil-rich calcarenite, light brownish carbonate breccia, and light brownish carbonate gravel. Dispersed sub-angular to sub-rounded fragments are often seen in the nannofossil-rich calcarenite. Clasts within the carbonate breccia and carbonate gravel consist of claystone and limestone, which are suspended in a clay matrix. Drilling disturbance is typically

severe and brecciated. The dominant lithology changes in Cores 45R through 55R from dark gray claystone and gray silty claystone at the top of the interval to gray silty sandstone with pyrite nodules at the base. Bioturbation is generally light to moderate in the silty claystone. Drilling disturbance is generally slight through this interval, although biscuits are common. Another downhole change in lithology occurs in Cores 56R through 61R, with a shift from light green calcarenite to conglomerate and light yellowish brown massive limestone. The conglomerate is dominated by carbonate pebbles. Smear slide analysis supports the lithologies identified through macroscopic core description. Detrital minerals include abundant quartz, feldspar, and micas, with trace to rare abundance of heavy minerals, including hornblende and tourmaline.

The biostratigraphers examined all core catcher samples and additional samples from split core sections of Cores U1456D-32R through 61R (749.8–1018.56 mbsf). Calcareous nannofossils are generally common, with the exception of a few barren intervals, and are generally moderately to well preserved. Samples barren of planktonic foraminifers alternate with samples containing common planktonic foraminifers. When present, planktonic foraminifers are moderately to well preserved. Calcareous nannofossil and planktonic foraminifer biostratigraphy agree that the interval from U1456D-32R to 38R, is late Miocene in age. Both the planktonic foraminifer and nannofossil assemblages identified below Core 38R represent mixed assemblages of species of late Eocene, Oligocene, and early Miocene age. The significant reworking of Paleogene and early Neogene calcareous nannofossils and planktonic foraminifers hampers biostratigraphic interpretation through this interval. Diatoms and radiolaria are absent in all samples examined.

The geochemists continued to collect samples for shipboard analysis of headspace gas, interstitial water chemistry, and bulk sediment geochemistry. Headspace gas was measured in each core from Hole U1456D. C_1 values are low (<2300 ppmv). C_2 and C_3 values are very low, with maximum values of only 6 ppmv and 2 ppmv, respectively. Sediment samples from Hole U1456D are currently in preparation for CHNS analysis. Analysis of $CaCO_3$ shows that much of the cored interval contains low amounts of carbonate (typically <16 wt%). The geochemists also started sample preparation for onboard organic extractions. Sampling for interstitial water extraction was discontinued below Core U1456D-43R (~865 mbsf) when adequate interstitial water was no longer extractable from a 15 cm whole-round sample. Salinity, pH, alkalinity, phosphate, ammonium, and major and minor ion measurements have been completed for the Hole U1456D interstitial waters. Salinity remains near 32, whereas the pH shows a slight increasing trend and alkalinity decreases down to 650 mbsf, and then increases slightly below that depth. The concentration of phosphate is lower than the detection limit below 420 mbsf and sulfate remains low throughout. Concentrations of chloride, bromide, calcium, and sodium increase with depth, whereas those of potassium and magnesium decrease with depth in Hole U1456D. Minor element concentrations either remain unchanged from concentrations measured in Hole U1456A or decrease slightly, except for strontium and lithium, which increase below 600 mbsf.

The Microbiology Laboratory continued to examine samples from Hole U1456B and confirmed the presence of fungal assemblages. Additional fungal mycelium assemblages were detected in Core U1456B-4H (19.60–29.03 mbsf). This interval is dominated by the microscopic benthic marine invertebrate kinorhynchs (brownish yellow color, 100 μm across, with a head containing curved spines), which feed on diatoms, protozoans, and organic material.

Paleomagnetic and anisotropy of magnetic susceptibility analyses from Site U1456 are completed for Hole U1456D. Samples from Core U1456D-57R show a normal polarity, which we interpret as Chron C5n (less than ~11 Ma). Two samples from Core 59R indicate reverse polarity that we tentatively assign to Chron C5R, between ~11 and 12 Ma. We have also begun some exploratory rock magnetic analyses focusing on likely proxies for continental weathering, such as the presence of detrital hematite.

Physical properties measurements were completed for Hole U1456D. Thermal conductivity measurements were conducted on split sections when possible, with values varying between 1 and 2 W/(m·K). Porosity is generally low (~40%) in samples from Hole U1456D, with some having measured porosity <20%. Discrete *P*-wave measurements were made on the working half of split cores on the Section Half Measurement Gantry (SHMG) when the core material was still saturated after splitting. *P*-wave velocities reached >3 km/s near the bottom of the hole; however, we were unable to measure *P*-wave velocity in most of the samples. Magnetic susceptibility (MS), natural gamma radiation (NGR), and density correlate well with lithologic changes seen in the cores. Lower density, NGR, and MS values characterize the carbonate ooze/chalk. The lowest NGR and MS values are seen in calcarenite rock deeper in the hole, with relatively high density and low porosity. In comparison, claystone, sandstone, and siltstone intervals have higher NGR and MS.

Education and Outreach

We conducted nine ship-to-shore events during the week with schools in the USA and India, as well as a fossil festival in the UK. We connected with 25 undergraduate students in a petrology class at Midwestern State University, Texas, USA. We also connected with two high schools in India: one in Mumbai (25 students) and one in Goa (40 students). We conducted events with graduate students and researchers at three universities: Banaras Hindu University, Varanasi, India (50 people); Louisiana State University, USA (seven people); and the School of Earth Sciences at SRTM University, Nandad, Maharashtra, India (30 people). Finally, we spoke with first graders in Arlington, Texas (48 students) and high school students in Los Angeles, California, USA (13 students). We ended the week with an event at a fossil festival in Lyme Regis, UK.

Technical Support and HSE Activities

The following technical support activities took place during Week 5.

Laboratory

- Completed comparison of color reflectance spectrometry results between the spectrometer on the Section Half Multisensor Logger (SHMSL) and the hand-held Minolta at the Co-Chief's request. Based on these results, all core sections going forward will be scanned by both the SHMSL and the Minolta. No cores already in storage will be brought up for scanning.
- Obtained diffractograms for goethite (G) and hematite (H). Rescanned samples out to 60º 2θ to examine for traces of goethite and hematite. This will help focus comparison of the SHMSL and Minolta spectrometry results. A few samples have small peaks that are likely goethite or hematite (or both), so we will continue to evaluate this approach of using the first derivative of the reflectance spectrum ($dR/d\lambda$) instead of the reflectance spectrum itself.
- Downloaded new Ocean Optics "Ocean View" software, which is the replacement for the older "Spectra Suite" software.
- The crest amplifier on the superconducting rock magnetometer (SRM) blew resistors. Since it and its components are very old, a decision was made to replace it with new one. The old one will be sent to shore. Currently we are using the old Dtech amplifier.
- The Special Task Multisensor Logger (STMSL) is not currently in use, but tests with NI card show no dropped data.
- Whole-Round Multisensor Logger (WRMSL) and STMSL do not use the new calibration factors for *P*-wave or gamma ray attenuation (GRA) unless the user exits the software and restarts it, as those factors are stored in the config file, which is read only at startup. New version of software needs to be able to load a new calibration as soon as it is saved.
- RGB data from the Section Half Imaging Logger (SHIL) are offset by 4–5 cm. Analysis shows that this problem first surfaced during Expedition 353. We are awaiting a fix from the shipboard programmers.
- Air conditioning unit #2 in core reefer was reported to leak refrigerant. Ship engineers report that the leak comes from inside the fan coil.
- Seawater samples were taken from 0, 5, 10, and 15 m below the sea surface for the paleontologists to complete a study of the plankton assemblages in the area.
- Continued troubleshooting the source rock analyzer (SRA) and communicating with vendor.
- Obtained a reasonable calibration curve for GC2 with PFMD.

HSE Activities

- Tested safety shower and eye wash stations.
- Conducted chemical spill drills.