

IODP Expedition 355: Arabian Sea Monsoon

Week 7 Report (10–16 May 2015)

Introduction

This week we completed coring in Hole U1456E after installing a reentry system to ~744 m below seafloor (mbsf) and then drilling ahead to 970.0 mbsf during Week 6. Hole U1456E was cored to 1109.4 mbsf. After pulling out of the hole for a bit change, we were unable to trip the drill string back to bottom and ultimately decided to abandon the hole, which ended operations at Site U1456. We then decided to spend our remaining time at alternate proposed site IND-06B (U1457) in an attempt to meet the Paleogene and basement targets of the expedition. The scientists characterized all cores from Hole U1456E, completed some additional analyses from previous holes at Site U1456 to further constrain the age model, and began to finalize the Site U1456 report.

Operations

Hole U1456E (IND-03C)

We continued rotary core barrel (RCB) coring in Hole U1456E through Core U1456E-19R to 1109.4 mbsf with the rate of penetration varying from 2.9–7.0 m/h. To enhance hole cleaning the drillers pumped 40-barrel high viscosity mud sweeps after each core. These were pumped at high annular velocity all the way to the surface prior to recovering the core barrel so that the cuttings from the entire cored interval would be flushed from the hole. After recovering Core 19R, we decided to recover the drill string, inspect the outer core barrel assembly, and change the bit, since the present bit was approaching 60 h of use. We pumped a final mud sweep from the total depth of the hole, and then displaced the open hole section with 125 barrels of heavy mud. We began to pull out of the hole, but had to wait until the drill bit was inside the 10¾ inch casing shoe at 735.2 mbsf before we could set back the top drive, indicating that the formation was beginning to impinge on the open hole below the casing. Once the top drive was set back, the drill string was pulled up to 36.6 mbsf, the circulating head picked up, and the reentry cone thoroughly flushed with seawater to remove any remnant cuttings or drilling mud that might inhibit the reentry attempt. The drill bit cleared the seafloor at 2330 h on 12 May and the remaining drill string was recovered back to the ship. The bottom-hole assembly (BHA) was racked back in the derrick and the mechanical bit release (MBR) and coring bit were removed, clearing the rotary table at 0740 h on 13 May.

Coincident with the decision to trip the drill string for a bit change, we were approached and contacted by an Indian Navy ship which informed us that we would have to move because the Indian military was planning to conduct a live fire weapons exercise the following morning (13

May) between 0800 and 1200 h. We informed the boarding officer (1) that we were in international waters conducting scientific research under the International Ocean Discovery Program (IODP) in collaboration with the Indian government, and (2) that our drill string was over 1100 m below the seafloor and that it would take many hours to recover our drill string and prepare to get underway, making it impossible for us to vacate the zone of operation before their deadline. After a number of shorebased entities were contacted (Siem, IODP management, Indian Ministry of Earth Sciences) the situation was ultimately resolved when the military moved the prohibited zone away from our location.

On 13 May, we prepared a new RCB CC-4 core bit and new MBR and deployed the new BHA. We lowered the drill string to 3597.6 m below rig floor (mbrf) and deployed the subsea camera for reentry. Shortly after deployment, the camera had to be recovered due to a network communication problem. The issue was resolved quickly and at 1630 h the camera was again deployed. While running to bottom, the drilling line was slipped and cut and the RigWatch drawworks encoder recalibrated. At 1900 h the ship began maneuvering for reentry. Picture quality was poor, primarily as a result of the seafloor around the reentry cone being covered with white drilling mud. The backscatter became worse as the camera got closer to the seafloor and that, coupled with particles in the water column, created a severe glare. Attempts to reenter Hole U1456E continued for over 18 h until 1315 h on 14 May when the camera failed completely and had to be recovered back to the ship. During this time multiple unsuccessful stab attempts were made, which further reduced visibility. After recovering the subsea camera, we attempted to disconnect the camera iris auto-adjust feature; however, this was unsuccessful. The spare black and white camera was installed and this camera provided a better picture, although the other lighting and visibility issues remained. The subsea camera was redeployed and reached the seafloor by 1615 h on 14 May and attempts at reentering Hole U1456E resumed. With the improved picture quality and elapsed time for some of the particles to settle out of the water column, we finally reentered Hole U1456 at 1900 h after an additional 2¾ h of maneuvering.

We positioned the bit just inside the throat of the reentry cone to thoroughly flush it with seawater in an attempt to remove the veneer of cuttings and drilling mud that masked all of the cone markings. The top drive was set back and the subsea camera recovered to the ship. At 0000 h on 15 May, we began lowering the pipe inside the casing until encountering an obstruction at 725.6 mbsf while the bit was still within the casing near the casing shoe. Just as on Hole U1456D, the obstruction was easily passed after picking up the top drive, deploying an RCB wash barrel, and circulating through the obstruction. The pipe was advanced to 822.7 mbsf with minimal rotation or weight on bit. The next 12 h were spent unsuccessfully washing and reaming the hole in an attempt to reach to the total depth of the hole (1109.4 mbsf) to resume RCB coring. The deepest the bit could be advanced was 936.0 mbsf and several momentary episodes of stuck pipe were experienced during these attempts. We decided to abandon Hole U1456E and concentrate on achieving at least some of the remaining expedition objectives at another location. After reviewing the sites available, the collective science decision was to proceed to alternate proposed site IND-06B (Site U1457), core two shallow advanced piston

corer (APC) holes, and then attempt to reach basement in the third hole using the RCB coring system. At 1530 h on 15 May, we began to pull the pipe out of the hole. Just as in the previous hole, the top drive was required in order to pull the bit back into the casing shoe, and drag continued even while pulling the bit up inside the casing. We speculate that this was as a result of a clay ball on the core bit being dragged into the casing from the open hole. The pipe trip into the casing was interrupted briefly (30 min) to repair a ruptured hydraulic line on the iron roughneck. Ultimately the bit was pulled clear of the seafloor at 2350 h on 15 May and by 0800 h on 16 May, the ship was secured and underway for Site U1457 (IND-06B).

Transit to Site U1457 (IND-06B)

During the short transit to Site U1457, the rig crew conducted rig maintenance tasks and prepared the subs, bit, lockable float valve (LFV), etc. required in the APC/extended core barrel (XCB) coring BHA. The thrusters were lowered and the sea voyage officially ended at 1330 h on 16 May. The 62 nmi distance was covered in 5.5 h at 11.3 kt.

Site U1457 (IND-06B)

We continued preparing the APC/XCB BHA immediately upon arrival at the site, and once the vessel was positioned over the site coordinates a depth to seafloor determination was made using the precision depth recorder (PDR). The estimated seafloor depth corrected to the rig floor rotary stool was determined as 3527.4 mbrf.

Hole U1457A (IND-06B)

We completed preparing the BHA, added the two stands of 5½ inch transition drill pipe, and then lowered the pipe to 3503.4 mbrf. The bit was positioned at a depth of 3521.0 mbrf or 6.4 m above the determined PDR depth. The bit was positioned slightly higher than normal because at the last site 62 nmi away, the actual seafloor was determined to be 1.6–2.5 m shallower than the PDR depth. We prepared an APC core barrel and attempted to spud Hole U1457A. After the first attempt retrieved only water, the bit was lowered 3.0 m and a second water core was recovered. The bit was lowered again and the third attempt at spudding was successful, recovering 8.76 m of core and establishing a seafloor depth of 3534.3 mbrf. Coring in Hole U1457A started at 0045 h on 17 May.

Science Results

The sedimentologists described cores from Hole U1456E (U1456E-3R through 19R; 970.0–1104.52 mbsf) using a combination of visual core description, microscopic investigation of smear slides and thin sections, core imaging, spectral color scanning, and magnetic susceptibility. The dominant lithologies of these cores are calcarenite, calcilutite, claystone, breccia, and conglomerate with minor amounts of limestone, nannofossil chalk, and sandstone.

Some intervals are folded or faulted and slickensides occur. The light greenish calcilutite and calcarenite contain foraminifers. The light greenish to light brownish claystone is nannofossil rich with strong bioturbation, whereas the dark gray claystone is massive or laminated. Pyrite nodules are often found in the claystone. The bottom of Core 19R shows a change in lithology to dark blackish gray sandstone interbedded with thin- to medium-bedded silty claystone. Magnetic susceptibility also increases from ~20 SI units to close to 400 SI units at this lithologic change. Smear slide analysis agrees with the lithologies identified through macroscopic core description. Detrital minerals are in trace or rare amounts and include quartz and micas, with trace amounts of heavy minerals.

The biostratigraphers analyzed core catcher samples and additional samples from split core sections from Cores U1456E-3R through 19R (970.0–1104.52 mbsf) for calcareous nannofossil and planktonic foraminifer biostratigraphy. Calcareous nannofossils are generally common to abundant, with preservation varying from poor to moderate throughout the interval. The assemblages primarily consist of a mix of Paleogene and early Neogene species throughout much of the sampled interval. At the change in lithology in Core U1456E-19R, the nannofossil assemblage is consistent with an early to middle Miocene age. Planktonic foraminifers are rare to common in abundance in most of the samples examined but some are poorly preserved because of intense recrystallization. Planktonic foraminifers represent mainly mixed assemblages of species that are middle–late Eocene, Oligocene, and early Miocene age, except for one sample containing an early Miocene assemblage with no older material mixed in. The significant reworking of Paleogene and Neogene species hampers biostratigraphic interpretation, but preliminary results indicate that the cored interval in Hole U1457E is early to middle Miocene in age.

Hole U1456E cored an interval overlapping the base of Hole U1456D, from ~970 m to 1018 mbsf. The two holes have similar lithologies over the common interval (calcarenite, breccia, and claystone), as well as similar levels of natural gamma radiation activity and magnetic susceptibility. Despite this, it is impossible to correlate cores between the two holes with any degree of certainty. Clearly there are clay intervals in each hole that either were not cored or are not present in the other hole.

The geochemists completed CHNS analysis of sediment samples from Holes U1456D and U1456E. Carbonate content was measured on an additional 69 samples from Hole U1456E, and those samples are being prepared for CHNS analysis. Carbonate content is generally high throughout much of Hole U1456E (65–90 wt%), corresponding to the calcarenite, calcilutite, limestone, and chalk intervals. A few samples have extremely low (<1 wt%) carbonate content. Twenty-two samples were extracted using organic solvents, and the total lipid extract (TLE) was combined, concentrated, and stored in 2 mL vials.

The paleomagnetists resampled and measured a few key intervals from Holes U1456A and U1456D to improve the definition of some geomagnetic reversals and to provide tighter

chronologic constraint for the Site U1456 age model. They also continued performing rock magnetic analyses on samples from Hole U1456A to determine the magnetic mineralogy content in the sediments.

Physical properties measurements were completed for Hole U1456E to provide basic information for characterizing the cored section. Variations in bulk density and magnetic susceptibility are interpreted as intervals with increased abundance of biogenic calcareous material (e.g., calcarenite shows low bulk density and magnetic susceptibility values) or high terrigenous input (e.g., sand has higher magnetic susceptibility). Natural gamma radiation (NGR) is generally low throughout the cored interval, except toward the base of the hole, where a distinct increase in NGR is associated with sand. Thermal conductivity measurements show values up to 2 W/(m·K), consistent with measurements from near the base of Hole U1456D. Porosity and grain density values are consistently low (~20% and 2.7 g/cm³, respectively); however, two claystone samples have very low bulk density measurements of 1.8 g/cm³ and high porosity near 60%. Discrete *P*-wave measurements show high values of up to 3400 m/s near the base of the hole.

Education and Outreach

We conducted eight ship-to-shore events during the week, including four separate events arranged by the Virginia Museum of Natural History (USA). We interacted with groups of elementary school students in Birmingham (UK), Brooklyn, New York (USA), Milan (Italy), and Bronx, New York (USA). The museum hosted events with elementary, middle, and high school students, as well as an adult “science café” evening.

Technical Support and HSE Activities

The following technical support activities took place during Week 7.

Laboratory

- We continued processing cores from Hole U1456E.
- We continued to investigate an apparent offset in RGB position data; however, there is still no resolution.

HSE Activities

- Tested safety shower and eye wash stations.
- An abandon ship and fire drill was held on 16 May. IODP technical staff observed the fire drill procedure.