

IODP Expedition 355: Arabian Sea Monsoon

Week 8 Report (17–23 May 2015)

Introduction

This week we continued coring operations at Site U1457. Hole U1457A was completed to 144.8 m below seafloor (mbsf) using both the advanced piston corer (APC) and half-length APC (HLAPC) systems. Hole U1457B was cored to 204.7 mbsf, also using both the APC and HLAPC. In order to advance the depth of the hole more quickly, we followed a 4.7 m cored interval with a 4.8 m drilled interval. We ultimately terminated Hole U1457B to preserve enough time to reach our basement objectives in Hole U1457C. Hole U1457C was drilled without coring to 191.6 mbsf, and then cored using the rotary core barrel (RCB) system to 715.4 mbsf by the end of the week. The scientists processed cores from all three holes and also finished the Site U1456 reports.

Operations

Hole U1457A (IND-06B)

Oriented APC coring using nonmagnetic core barrels continued in Hole U1457A through Core U1456A-12H to 111.2 mbsf. Core 12H had an incomplete stroke and upon recovery was found to have a shattered core liner that required pumping out. We then continued coring using the HLAPC through Core 19F to a total depth of 144.8 mbsf for Hole U1457A. To advance the hole more quickly we used the technique employed during Expedition 354 where a 4.7 m HLAPC cored interval was followed by a 4.8 m drilled interval. At 1900 h on 17 May we terminated Hole U1457A in the interest of time. The drill string was tripped to the seafloor with the top drive in place and at 2015 h the bit cleared the seafloor, ending Hole U1457A and beginning Hole U1457B.

Hole U1457B (IND-06B)

The ship was offset 15 m west of Hole U1457A and the bit was positioned at 3528.5 m below rig floor (mbrf). Hole U1457B was started at 2140 h on 17 May. The first core recovered 3.22 m, establishing a seafloor depth of 3534.8 mbrf. We continued APC coring with nonmagnetic core barrels and core orientation through Core 13H to 110.7 mbsf. Cores 10H and 12H required pumping out and we also drilled ahead without coring over a 3 m interval (88.7–91.7 mbsf) to realign the core breaks for optimized stratigraphic correlation. We then continued coring with the HLAPC system from Core 14F through 33F to 204.7 mbsf, where the hole was terminated in the interest of time. The drill string was pulled back to 181.2 mbsf with the top drive in place, and then after racking the top drive, the pipe trip continued with the bit clearing the seafloor at

2250 h on 18 May. We had recovered the drill string to 2108.0 mbrf when a hydraulic hose on the starboard pipe racker ruptured. This caused a stand of drill pipe to drop into the pipe racker, damaging the center chain shock absorber and also causing the chain to jump off the sprocket. The damage was repaired in 1 h and the pipe trip resumed with the bit clearing the rig floor at 0810 h on 19 May. This ended Hole U1457B and marked the beginning of Hole U1457C.

Hole U1457C (IND-06B)

The ship was offset 15 m east of Hole U1457B and we assembled a four-stand RCB bottom-hole assembly (BHA). The drill string was lowered to 199.0 mbrf when another repair on the starboard pipe racker was required. It was fixed in 1 h and at 1100 h on 19 May the pipe trip resumed. The top drive was picked up at a depth of 3509.6 mbrf, the pipe was spaced out for spudding, and an RCB wash barrel was deployed. Hole U1457C was started at 1830 h on 19 May. The seafloor depth was established by tagging the seafloor at 3534.0 mbsf. Drilling without coring continued for 5.5 h and reached the target depth of 191.6 mbsf. The interval was drilled at a rate of 95.8 m/h. The wash barrel was recovered and at 0030 h on 20 May we began to RCB core using nonmagnetic core barrels. Core recovery in the first few cores was very poor (<0.5 m), most likely due to the formation being washed away by the RCB bit jets. As the material became more lithified the recovery improved. To preserve the hole quality as much as possible, the drillers used the least amount of circulation possible to maintain a clean hole. This required more mud sweeps to reduce hole erosion at the top of the hole as much as possible. We pumped 30-barrel high-viscosity mud sweeps every other core (approximately every 19 m). This technique appears to be working as the drillers are seeing little if any fill on connections and the hole appears to be in reasonably good shape at this time. As of midnight on 23 May, the bit had reached 715.4 mbsf in Hole U1457C and overall recovery for the cored section of the hole was just under 36%.

Science Results

The sedimentologists described Cores U1457A-1H to 19F (0–144.81 mbsf), U1457B-1H to 33F (0–205.20 mbsf), and U1457C-2R to 48R (191.60–639.66 mbsf) using a combination of visual core description, microscopic observation of smear slides, core imaging, spectral color scanning, and magnetic susceptibility. The dominant lithologies of Holes U1457A and U1457B are similar, and are tentatively divided into two units with the boundary at U1457A-8H-7, 23 cm, and U1457B-9H-2, 98 cm, respectively. The upper unit is characterized by nannofossil ooze, foraminifer-rich nannofossil ooze, calcareous ooze, clay with nannofossils, nannofossil-rich clay, and nannofossil-rich clay with silt—an assemblage that is essentially similar to Unit I of Site U1456. In contrast, the lower unit is dominantly silty clay, which is similar to the upper part of Unit II at Site U1456. Magnetic susceptibility (MS) also increases below this lithologic boundary. The observation of smear slides from Holes U1457A and U1457B shows that detrital

minerals (quartz, feldspar, mica, and heavy minerals) occur only in trace amounts in the upper unit, whereas the lower unit contains abundant detrital minerals.

Cores U1457C-2R to 21R consist primarily of light brownish silty clay or silty claystone. Cores 22R to 48R are characterized by intervals of light gray nannofossil chalk and dark greenish gray nannofossil-rich claystone, alternating with brownish gray silty claystone and silty sandstone. The nannofossil-rich claystone and nannofossil chalk are intensively bioturbated, with diverse burrows including *Skolithos*, *Zoophycos*, *Nereites*, and *Chondrites*. In contrast, the silty claystone and silty sandstone are mostly massive, but show normal grading and erosive sharp contacts. Detrital minerals are scarce in the calcareous-rich sediments, but common in the silty sand/sandstone. Hornblende, actinolite, and epidote are common, whereas zircon, tourmaline, rutile, titanite, kyanite, and clinopyroxene occur only in trace amounts.

The biostratigraphers examined core catcher samples and additional samples from split core sections from Holes U1457A (8.69–144.7 mbsf) and U1457B (3.17–205.15 mbsf), and Cores U1457C-2R through 55R (191.90–707.08 mbsf). Calcareous nannofossils and planktonic foraminifers are generally abundant and well preserved in samples from Holes U1457A and U1457B, although below Core U1457B-17R planktonic foraminifers are mainly absent. Nannofossils from Hole U1457C vary in abundance from few to common depending on the lithology sampled and are moderately well preserved. Planktonic foraminifers in samples from Hole U1457C alternate between absent and common, but when present planktonic foraminifer preservation is generally moderate to good. Well-preserved diatoms and a few radiolaria were found in the mudline water sample taken from Hole U1457B, as well as in the uppermost sections of Core U1457C-1H, but were generally absent in other samples examined. The succession of calcareous nannofossil and planktonic foraminifer events indicate that Holes U1457A and U1457B are early Pleistocene to Recent in age. The interval from Core U1457C-2R to 55R spans the late Miocene through early Pleistocene, with an unconformity encompassing the Miocene/Pliocene boundary.

The geochemists collected samples for shipboard analysis of headspace gas, interstitial water chemistry, and bulk sediment geochemistry analysis from Holes U1457A, U1457B, and U1457C. Methane values begin to increase significantly at ~65 mbsf and reach a maximum of ~36,000 ppmv at 166 mbsf. This coincides with a decrease in sulfate concentration over the upper 60 mbsf and a concomitant increase in alkalinity caused by anaerobic sulfate reduction over the same interval. Concentrations of calcium and magnesium decrease in the sulfate reduction zone as they are precipitated out as carbonate as a result of the increase in alkalinity. Bromide concentration increases with depth, whereas those of potassium, chloride, sodium, and magnesium decrease with depth in Holes U1457A and U1457B. Bulk sediment geochemistry results from Holes U1457A and U1457B show that calcium carbonate content, total carbon, and total organic carbon are generally high in the upper 70 mbsf, with a significant decrease below that depth.

Twelve microbiology whole rounds were collected from Holes U1457A and U1457B for post-expedition microbial community analysis (lipids and DNA). Fluorescent microspheres were added to the core catcher sub as a contamination tracer when microbiology sampling was planned. The concentrations of microspheres measured on samples from the exterior of the whole rounds were higher than those measured from a sample from the intermediate position. Microspheres were completely absent in the interiors of these cores, indicating no contamination. Even the exteriors of the cores from these holes showed relatively low concentrations of microspheres.

This week the paleomagnetists devoted themselves to analyzing samples from Site U1457. Samples from U1457 are mostly well behaved and the equipment problems experienced earlier have been resolved. Paleomagnetic measurements on Site U1457 samples were prioritized to define the magnetostratigraphic boundaries as precisely as possible within the time remaining. All interpretations are based on fully demagnetized discrete samples.

Physical property data were collected for Holes U1457A through U1457C on whole-round core sections using the Whole-Round Multisensor Logger (WRMSL), Special Task Multisensor Logger (STMSL), and Natural Gamma Radiation Logger (NGRL), with additional measurements on split cores and discrete samples. In Holes U1457A and U1457B, magnetic susceptibility is high in the upper ~75 mbsf. Both the bulk density and natural gamma radiation (NGR) are comparatively low in the upper ~75 mbsf and increase below that depth. In Hole U1457C, low magnetic susceptibility intervals usually have comparatively high NGR, except for in the lower part of the hole.

Discrete measurements of bulk density, shear strength, and thermal conductivity show that these parameters generally increase with depth from 1.5 to 2.0 g/cm³, 10 to 70 kPa, and 1 to 1.6 W/(m·K), respectively. In contrast, porosity decreases from nearly 80% to 40% and the void ratio from 3.0 to 0.5 over the same interval. In the uppermost 130 mbsf, *P*-wave velocity measurements increase from 1.5 to 1.6 km/s, and then increase again between 600 and 640 mbsf from 1.8 to ~2.0 km/s. Acquired data correlate with lithology, composition, and compaction.

Three temperature measurements were collected with the advanced piston corer temperature tool (APCT-3) in Hole U1457A. These results indicate a geothermal gradient of ~53°C/km in the upper 93 mbsf. This, coupled with the average thermal conductivity of 1.12 W/(m·K) in the upper 98 mbsf, suggests a heat flow of 60 mW/m² for Site U1457, slightly higher than that at Site U1456.

Education and Outreach

We conducted nine ship-to-shore events with five different countries this week. We spoke to elementary school students in New York and Washington, D.C., middle school students in

Texas, and high school students in Illinois (USA). We also conducted events with middle school students in Germany and a group of high school students in Kathmandu, Nepal. We held an event with researchers at the National Centre for Antarctic and Ocean Research (NCAOR) in Goa, India. Finally, we connected with a group of adult rotary club members in Germany, and also held an event directed at families attending an “Ice and Climate” science festival in Newcastle, UK.

Technical Support and HSE Activities

The following technical support activities took place during Week 8.

Laboratory

- We continued processing cores from Site U1457.
- The PC board failed on the Section Half Imaging Logger (SHIL); the board was replaced with a spare and the SHIL is back to normal operation.
- User error was noticed on the NGRL where a user can scan a section barcode label without being in the “SCAN” window, and the instrument will run without proper text ID. This resulted in a file naming error, and consequently no file is uploaded. We are able to catch these errors prior to splitting and the core sections re-run. We are proposing software modifications to prevent this from occurring.
- The End of Expedition schedule was posted.
- CFI outlets were installed in the Rad Van.

HSE Activities

- Tested safety shower and eye wash stations.