IODP Expedition 355: Arabian Sea Monsoon

Week 2 Report (6–12 April 2015)

Operations

Transit to Site U1456 (IND-03C)

The transit to Site U1456 was uneventful. The 941 nmi trip (including 2 mi under pilot) was made at an average speed of 11.1 kt. The sea voyage ended at 1054 h (UTC + 5.5 h) on 9 April 2015, and command of the vessel was switched from the bridge to dynamic positioning (DP) control.

Hole U1456A (IND-03C)

Initial operations included picking up drill collars from the forward main deck pipe rack, spacing out the advanced piston corer (APC)/extended core barrel (XCB) coring systems, and drifting and strapping all tubulars during the first pipe trip of the expedition. The bottom-hole assembly (BHA) included two stands of 5½″ drill pipe, a tapered drill collar, five 8¼″ control length drill collars, a nonmagnetic drill collar, head sub, top sub, latch sub, seal bore drill collar (which serves as the outer core barrel for the coring system), bit sub with a lockable float valve, and a "used" 9⅞″ Russian polycrystalline diamond compact (PDC) APC/XCB core bit.

A Falmouth Scientific positioning beacon was deployed at 1108 h on 9 April 2015. After pumping a drill string wiper plug, we deployed the APC coring system, spudding Hole U1456A at 0210 h on 10 April after offsetting the ship 15 m to the west of the original prospectus coordinates for the drill site. We positioned the bit at a depth of 3645.0 mbrf and the first APC core was on deck at 0235 h, recovering 4.54 m of sediment and establishing a seafloor depth to the rig floor of 3650.0 mbrf. This hole was originally planned as an APC/XCB hole to ~250 m below seafloor (mbsf); however, because the hole conditions were better than anticipated, we elected to continue drilling to ~600 mbsf as was planned initially for Hole U1456C.

Oriented APC coring using nonmagnetic core barrels and whirl-packs for microbiology contamination testing continued through Core U1456A-16H to a depth of 139.3 mbsf. The advanced piston corer temperature tool (APCT-3) was deployed on Cores 4H (33.0 mbsf), 7H (61.5 mbsf), 10H (90.0 mbsf), and 13H (118.5 mbsf). The first deployment was unsuccessful due to flooding of the APC shoe pressure case. After two successive partial strokes on Cores 15H and 16H, with the latter returning only a small amount of sediment in the core catcher, we decided to switch to the half length advanced piston corer (HLAPC). Coring continued using the HLAPC coring system from Core 17F through 40F to a depth of 249.3 mbsf. Although we originally planned to end Hole U1456A at 250 mbsf, we opted to continue coring due to the good hole conditions and good recovery. At the end of the week, Core 68F had been cut to a depth of 380.1 mbsf.

Science Results

Site U1456 (proposed Site IND-03C) is located in the Arabian Sea within Laxmi Basin, approximately 475 km from the western margin of India and 820 km from the modern mouth of the Indus River. Laxmi Basin is flanked by Laxmi Ridge to the west and the Indian Subcontinent to the east. The nature of the crust in Laxmi Basin is unknown. Thus, one of the primary objectives at this site is to core into basement to determine if it is true oceanic crust, transitional crust, intruded continental crust, or exposed serpentinized upper mantle. The sedimentary section cored above basement will address a number of scientific objectives related to the weathering and erosion history of the western Himalaya, including dating the base of the Indus Fan, as well as reconstructing environmental changes in the hinterland over the Cenozoic.

The sedimentologists described cores from Hole U1456A (Cores 1H through 14H; 0–124.58 mbsf) using a combination of visual core description, microscopic inspection of smear slides, core imaging, and scanning for color spectra and magnetic susceptibility. The dominant lithology in the upper part of the hole is white nannofossil ooze and nannofossil ooze with clay, intermixed with graded beds marked by sharp, erosional contacts at their bases, which we interpret as turbidites. The nannofossil ooze and ooze with clay are commonly bioturbated and also contain rare pyrite nodules. The graded beds vary in thickness from less than 1 cm to more than 10 cm, with the grain size ranging from coarse silt to fine sand. Drilling disturbance is minimal in the upper part of the hole. Smear slide analysis indicates that the nannofossil-rich sediment also contains foraminifers and rare sponge spicules. The graded beds contain some nannofossils, but also abundant detrital minerals including quartz, feldspar, mica, and a heavy mineral assemblage compatible with Indus River sediment derived from the Himalayas.

The biostratigraphers examined core catcher samples from Cores U1456A-1H through 44F (0–267.30 mbsf) for calcareous nannofossil, planktonic foraminifer, radiolarian, and diatom biostratigraphy. The calcareous microfossils indicate that the succession spans the upper lower Pleistocene to Recent. Calcareous nannofossils are generally abundant and well preserved, although their abundance decreases in the coarser grained intervals. Planktonic foraminifers are moderately to well preserved in Cores 1H through 10H, but show poorer preservation from Cores 11H to 20F. Below Core 21F, planktonic foraminifers are mainly absent in the core catcher samples examined. Radiolarians are only present in very low abundance in Cores 1H and 2H. The assemblage in Core 1H indicates a Late Pleistocene to Recent age, consistent with nannofossil and foraminifer biostratigraphy. Diatoms are absent in all samples examined.

The geochemists collected samples for shipboard analysis of headspace gas, interstitial water (IW) chemistry, and bulk sediment geochemistry analyses from Cores U1456A-1H through 44F (0–267.30 mbsf). The headspace gas analysis, as well as the pH, alkalinity, and salinity measurements on the IW samples are complete, with the remaining analyses ongoing. Methane values are very low in the upper 60 m of sediment, increase gradually with depth from 60 to 110 mbsf, and then decrease again. All values fall within the normal range of biogenic methane

production. Interstitial water samples were extracted by squeezing 5 cm whole-round samples (one per ~9.5 m of core). Salinity decreases over the upper 120 mbsf and then remains relatively constant below this depth. The pH increases slightly with depth, whereas the alkalinity varies significantly. Additional measurements for major and minor ion analysis of the IW samples are ongoing. Residual sediment from the IW squeeze cakes is being prepared for analysis of carbon, nitrogen, and sulfur. We also began preparing for on board extraction of molecular biomarkers.

We collected a total of 30 whole-round samples (nominally one per ~9.5 m of section except in coarse grained intervals) for microbiology. The whole rounds were subsampled using 50 cm^3 and 5 cm^3 sterile syringes. Samples for advanced molecular analysis were flushed with nitrogen, double sealed, and stored at –80ºC. Samples for shorebased cultivation were double sealed with nitrogen packs and stored at 4ºC for further processing. All subsamples for biomarkers, molecular tracers, and contamination analysis were stored at –20ºC. For contamination testing, known quantities of fluorescent microspheres were sealed in a bag and added to the core catcher sub of each core to be sampled for microbiology. Analysis of samples for microspheres is ongoing, but initial results show that most samples have little or no contamination.

Shipboard paleo- and rock magnetic studies for Site U1456 consisted of continuous measurements and progressive demagnetization of all archive half sections, measurement of the anisotropy of magnetic susceptibility, measurements and progressive demagnetization of discrete samples, and application of anhysteretic and isothermal remanent magnetization. Demagnetization of the discrete samples, coupled with the quasi-continuous measurements of the archive half, demonstrate that the drill string overprint is readily removed by 15 or 20 mT and we are optimistic that we will be able to obtain a reliable magnetostratigraphy. Cores U1456A-1H through 9H are uniformly normally magnetized, which we correlate to the Brunhes Chron (<0.78 Ma), which is in agreement with the available biostratigraphy. The anisotropy data clearly show the turbidite layers, which are quite anisotropic compared to the clay layers.

We measured physical properties on all whole round cores (>30 cm in length) from Cores U1456A-1H through 38F (0–239.95 mbsf) on the Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Radiation Logger (NGRL) after they had reached thermal equilibrium with ambient temperature (~4 h, ~20ºC). Gamma ray attenuation (GRA) bulk density, magnetic susceptibility, and *P*-wave velocity were measured at 2 cm intervals on the WRMSL. Each core section was then logged for NGR at 10 cm intervals with eight detectors. In addition, Cores 1H through 3H (0–23.39 mbsf) were logged on the Special Task Multisensor Logger (STMSL) for GRA and magnetic susceptibility at 5 cm intervals. Thermal conductivity measurements were conducted on whole round cores before splitting, approximately once per ~9.5 m of core. Discrete *P*-wave and shear strength measurements were made on the working half of the split cores on the Section Half Measurement Gantry (SHMG). Moisture and density (MAD) were measured on 10 cm^3 plugs collected from the working halves, approximately every other section (2–3 per core). Magnetic susceptibility shows variations that correlate with the alternation between the coarser graded beds, interpreted as turbidites, and the nannofossil-rich hemipelagic

sediment. Variation in NGR also correlates well with lithologic changes. *P*-wave velocities from the WRMSL are in agreement with the discrete *P*-wave measurements through Core 14H. Shear strength measurements are variable through Core 14H.

The downhole measurements group analyzed three temperature measurements from the APCT-3 tool, which indicate a geothermal gradient of ~56ºC/km. This, coupled with the average thermal conductivity of 1.25 W/[m·K] in the upper 274 mbsf, suggests a heat flow of 71 mW/m^2. The Schlumberger engineer also began testing the logging tools that will be deployed after the end of coring operations in Hole U1456A.

Technical Support and HSE Activities

The following technical support activities took place during Week 2.

Laboratory

- Continued training scientists in laboratory procedures.
- Recalibrated some instruments following a brief power outage.
- Shipboard labs began processing cores from Hole U1456A on Friday, 10 April.
- Began preparing G gun cluster and PFT pump for upcoming needs.
- KappaBridge in Paleomagnetics Laboratory was giving noisy results intermittently; problem was traced to the Agico standard being placed in a small bag alongside the read zone.
- Dtech in Paleomagnetics Laboratory was overheating due to voltage increasing; however, it was caught before any damage occurred. Scientists determined it is reliable with only one channel of the amplifier.
- Performed experiments to check the frequency-adjusted magnetic susceptibility loop calibration against the non-adjusted loop; found that Bartington's correction factor is approximately 7.5% too high.

HSE Activities

- Tested safety shower and eye wash stations.
- Abandon ship and security drill held on Monday, 6 April.