IODP Expedition 361: Southern African Climates

Week 8 Report (14–20 March 2016)

Operations

The week began during coring operations at Hole U1477A. Hole U1477A was cored to 102.5 m DSF using the APC coring system. Partial strokes were recorded on Cores U1477A-10H and 11H, the half-length APC (HLAPC) was deployed, and coring continued to 173.0 m DSF. The XCB system was deployed for Core U1477A-27X. Coring was terminated in Hole U1477A at 181.2 m DSF. The drill string was pulled from the hole with the bit clearing the seafloor at 0615 h on 14 March. A total of 182.53 m of core was recovered at Hole U1477A (101% core recovery).

The vessel was offset 20 m north of Hole U1477A and Hole U1477B began at 0705 h on 14 March. Based on a recovery of 4.1 m in Core U1477B-1H, seafloor was calculated to be 429.6 mbsl. The APC system was deployed for Cores U1477B-1H to 12H (0–108.6 m DSF). Following two partial strokes with the APC system, the HLAPC was used for Cores U1477B-13F to 26F (108.6–174.4 m DSF). After concluding coring operations in Hole U1477B, the drill string was pulled from the hole and the bit cleared the seafloor at 1910 h on 14 March. A total of 185.73 m of core was recovered at Hole U1477B (106% core recovery).

The vessel was offset 20 m south of Hole U1477A and Hole U1477C began at 1950 h on 14 March with a 1.0 m drilled interval. An estimated seafloor depth of 429.2 mbsl was used for initiating the hole. The APC system was used for Cores U1477C-2H to 10H (1.0–86.5 m DSF). Partial stokes were recorded for Cores U1477C-9H and 10H and the HLAPC was deployed for Cores U1477C-11F to 17F (86.5–119.4 m DSF). Coring in Hole U1477C was terminated at 119.4 m DSF. A total of 121.7 m of core was recovered from a 118.4 m cored interval (103% core recovery). The drill string was pulled from the hole with the bit clearing the seafloor at 0415 h and the rig floor at 0555 h on 15 March. The rig floor was secured for transit at 0630 h and the vessel was underway to Site U1478 at 0642 h.

After a 422 nmi transit, the vessel arrived at Site U1478 at 2215 h on 16 March. The thrusters were lowered and the heading was controlled at 2241 h. The APC/XCB bottom-hole assembly (BHA) and drill string were made up and deployed to the seafloor. Using the precision depth recorder (PDR) seafloor depth of 489.3 mbsl, APC coring began in Hole U1478A. Core U1478A-1H recovered 6.71 m and the seafloor depth was calculated to be 487.9 mbsl. Cores U1478A-1H to 21H penetrated from the seafloor to 196.7 m DSF. After significant overpull while removing Core U1478A-21H, the HLAPC was run for Cores U1478A-22F to 32F (196.7 to 248.4 m DSF). The drill string was then pulled out of the hole, clearing sea floor at 1805 h on 17 March. A total of 256.96 m of sediment was recovered over a 248.4 m cored interval in Hole U1478A (103% core recovery).

The vessel was offset 20 m to the north of Hole U1478A and Hole U1478B began at 1840 h on 17 March with a 1.0 m drilled interval. The hole was then cored using the APC system to 162.5 m DSF (Cores U1478B-2H to 19H). Core U1478B-19H was a partial stroke and required 90000 lb to pull out of the formation, so the HLAPC system was deployed for Cores U1478-20F and 21F. The APC system was used for Core U1478B-22H, resulting in another partial stroke and 80000 lb of overpull. The HLAPC was then used for Cores U1478B-23F to 34F. After reaching 247.3 m DSF, the drill string was pulled out of the hole with the bit clearing the seafloor at 1015 h on 18 March. A total of 246.85 m of core was recovered at Hole U1478B (100% core recovery). Interstitial water whole-round samples were taken from every core section in the upper 150 m CSF-A of Hole U1478B for shore-based analysis.

The vessel was moved 20 m east of Hole U1478A and Hole U1478C began at 1110 h on 18 March. The seafloor depth was calculated to be 489.9 mbsl after retrieving a 1.5 m mudline in Core U1478C-1H. The hole was washed down without recovery to 3.0 m DSF to offset coring gaps between holes for stratigraphic correlation. APC coring continued for Cores U1478C-3H to 21H (3.0–178.5 m DSF) and one interval was drilled without coring from 164.5 to 169.0 m DSF (Interval U1478C-20-2). The HLAPC was deployed for Cores U1478C-22F to 38F (178.5–248.3 m DSF). Three intervals that penetrated 4.0 m were drilled without coring in the HLAPC cored section. After completing coring operations in Hole U1478C, the drill string was pulled from the hole with the bit clearing the seafloor at 0219 h on 19 March. A total of 238.3 m of core was recovered over a 248.3 m cored interval (102% recovery).

The vessel was offset 20 m south of Hole U1478A and Hole U1478D began at 0310 h on 19 March. Core U1478D-1H recovered 6.7 m of sediment and the seafloor depth was calculated to be 490.7 mbsl. Hole U1478D was advanced without recovery from 6.7 to 8.7 m DSF to offset coring gaps for stratigraphic correlation. The APC system was deployed for Cores U1478D-3H to 17H (8.7–151.2 m DSF). A center bit was deployed and the hole was deepened 39.3 m without coring so that we could obtain cores from a deeper interval that had gaps in the stratigraphy. The HLAPC was deployed for Cores U1478D-19F and 20F (190.5–199.9 m DSF). The drill string was then advanced 2.0 m without coring and then Cores U1478D-22F to 24F (201.9–216.0 m DSF) were retrieved. A total of 175.97 m of core was recovered over a 172.7 m cored section (102% core recovery). After completing coring operations at Hole U1478D, the drill string was pulled from the hole. The bit cleared the seafloor at 1350 h on 19 March and the rig floor at 1540 h. The rig floor was secured for transit and the vessel began the transit to Site U1479 at 1630 h on 19 March.

Science Results

Site U1477

The sediments at Site U1477 consist of two lithologic units:

Unit I is composed of very dark gray to dark greenish gray sandy clay with foraminifers and nannofossils.

Unit II is composed of very dark gray to dark greenish gray silty clay with intermittent to frequent occurrences of sand layers. These sand layers contain quartz and clay and thicknesses range between centimeter to meter scale.

Bioturbation is not apparent in either unit. Macrofossils, including bivalve and echinoderm fragments, are present throughout the cores. Many of the cores show disturbance related to gas expansion.

Whole-round measurements of density, *P*-wave velocity, magnetic susceptibility (MS), and natural gamma radiation (NGR), as well as half-round measurements of RGB color, color reflectance, and MS were made for all cores from Site U1477. Water content, porosity, void ratio, bulk density, dry density, and grain density was measured on 61 samples from Hole U1477A. Thermal conductivity measurements were conducted on 14 cores from Holes U1477A and U1477B. Physical parameters show a complex pattern of high amplitude changes despite the relatively homogenous lithology. Average porosities are significantly lower when compared to the previously cored sites, suggesting a higher degree of sediment compaction.

Real-time stratigraphic correlation was possible at Site U1477 using magnetic susceptibility data. Holes U1477A, U1477B, and U1477C were used for the splice from 0 to ~85 m CCSF-A. Below ~85 m CCSF-A, the splice consists entirely of recovered sediment from Hole U1477B. A continuous stratigraphic splice was not possible at this site due to substantial gas expansion that led to core fracturing and variable core stretching between holes.

Site U1477 spans the Holocene to the Late Pleistocene. Two biostratigraphic datums are observed: the abundance crossover from *Gephyrocapsa caribbeanica* to *Emiliana huxleyi* at ~90 k.y. and the top occurrence of *Globigerinoides ruber* (pink) at ~120 k.y. Sedimentation rates, based on biostratigraphic datums as well as radiocarbon ages tied in from a nearby piston core, suggest deposition rates of ~1.5 m/k.y. in the upper parts of Hole U1477A that decrease to ~83 cm/k.y. in the lower parts of the hole. Calcareous microfossils are generally well preserved, although abundance is typically low. Planktonic foraminifer tests compose less than 1% of sediment particles in most samples, while less than 50 nannofossils per field of view are observed throughout most of the section. The planktonic assemblage, which includes the regular occurrence of pteropods, is joined by benthic foraminifers, ostracods, sponge and gorgonian spicules, molluscs, echinoderm plates, and fish otoliths. Siliceous microfossils make up a minor

component of the mudline and core catcher samples. Marine and freshwater diatoms, phytoliths, and sponge spicules are present, providing indications of both terrestrial and marine sources.

Paleomagnetic measurements from Site U1477 show a clear magnetic signal. For all holes, inclinations center around –50° during the Brunhes chron, which is typical for the site location. Rock-magnetic data acquired on discrete samples reveal phases of high ferrimagnetic mineral content that largely match MS data collected on archive section halves and whole cores. Variations in high-coercivity versus low-coercivity minerals reflect either a change in the composition of the terrigenous fraction or preferential magnetite dissolution.

Interstitial water chemistry and headspace gas concentrations show relatively intense early sediment diagenesis. The sulfate–methane transition appears at ~16 m CSF-A, below which sulfate is completely consumed and methane concentrations increase rapidly to a peak of ~75,500 ppmv at ~35 m CSF-A. Other redox sensitive elements, including iron, manganese, and barium, show intense enrichments due to remobilization according to their predictable zonation. Carbonate contents average 5 wt%, with a few intermittent layers of shell material that have carbonate contents up to ~20 wt%. The average total organic carbon content in Hole U1477A is 0.61 wt%.

Site U1478

Cores from Holes U1478A and U1478B were described. These cores contain dark greenish gray foraminifer sand alternating with dark greenish gray clayey silt with nannofossils or foraminifers. The sand is primarily composed of quartz. Shell fragments of bivalves, gastropods, and corals are common in the cores.

Whole-round measurements of density, *P*-wave velocity, MS, and NGR, as well as half-round measurements of RGB color, color reflectance, and MS, have been made on cores from Holes U1478A, U1478B, and U1478C. Water content, porosity, void ratio, bulk density, dry density, and grain density were measured on 81 samples from Hole U1478A. Thermal conductivity measurements were conducted on 16 cores from Hole U1478B.

Real-time stratigraphic correlation was possible while coring Holes U1478B, U1478C, and U1478D using MS data. A complete stratigraphic section was constructed from 0 to 248.4 m CSF-A, with the exception of a ~1 m gap at 195 m CSF-A.

The biochronology for Site U1478, based on calcareous nannofossils and planktonic foraminifers, shows that the recovered sediment spans the Late Pleistocene to the middle Pliocene (0 to ~3.9 Ma). The calcareous nannofossils and planktonic foraminifers are predominantly tropical to warm subtropical species with small numbers of temperate species in the lower part of Hole U1478A. Both calcareous fossil groups are generally abundant and well preserved. Foraminifers make up almost 50% of the sediment volume in sand layers and glassy, translucent tests occur commonly throughout the cored section. Calcareous nannofossil

abundance is more than 70% of sediment particles throughout the whole sequence. Diatoms are only present in the surface sediments while siliceous sponge spicules and phytoliths are rare components in the deeper sedimentary record. Most samples at Hole U1478A contain pteropods, benthic foraminifers, ostracods, sponge and gorgonian spicules, phytoliths, molluscs, fragments of deepwater corals, and fish otoliths.

The paleomagnetic inclination data at Site U1478 show phases of normal and reversed magnetic polarity. The Brunhes–Matuyama boundary was detected in Section U1478A-9H-2A. Other intervals of normal polarity can be tentatively linked to the Jaramillo and Olduvai subchrons. The base of the Matuyama chron cannot be constrained because the lower part of the core appears to be overprinted by reductive diagenesis. Measurements on the archive halves of Holes U1478B, U1478C, and U1478D and on the discrete samples from Hole U1478A are still in progress.

The sequence of biostratigraphic datums and magnetostratigraphic reversal boundaries indicates a sedimentation rate of ~9 cm/k.y. for the past ~1.5 Ma and ~4 cm/k.y. from 1.5 to ~3.9 Ma.

Preliminary geochemistry data from Site U1478 show more moderate diagenetic profiles than at Site U1477. Alkalinity peaks at 16.4 m CSF-A with a value of 9.8 mM. Chloride increases from the top of the cored section to ~23 m CSF-A, then decreases slightly over the next ~100 m, and finally increases toward the base of the section. Carbonate values average 27 wt%, with a range from 16 to 54 wt%.

Education and Outreach

Interactions

- Nine live broadcasts to: three classrooms in the USA, one classroom in Italy, one classroom in Spain, one classroom in France, one classroom in the UK, and an event for German high school students; 956 people reached (129 elementary students, 762 high school students, 65 university students).
- Reddit "Ask a Scientist" event was held over 2 h; 12 questions were addressed.

Social Media

- *JOIDES Resolution* blog (http://joidesresolution.org/): five posts, 869 reads so far.
- Facebook (https://www.facebook.com/joidesresolution): six posts, 9,116 people reached.
- Twitter (https://twitter.com/TheJR): six tweets, ~30–35 retweets, 2,709 followers, 3,426 impressions.
- Instagram (http://instagram.com/joides_resolution): six posts, hundreds of likes.

Technical Support and HSE Activities

Technical Activities

- Liquid nitrogen generator: Installing a new valve and actuator on the generator.
- Zebra printers: Testing in progress to determine cause of adhesive build-up issues inside the printers.

Computing Activities

- MUT uploader version 15: New version of the data uploader was released to ship production.
- End of Expedition: Data migration planning for the end of the expedition is complete.
- Mac Workstations: Finished installation of Matlab 2014b on all Mac workstations.

HSE Activities

- The weekly lifeboat and fire drill was held on 20 March.