IODP Expedition 361: Southern African Climates

Week 4 Report (15–21 February 2016)

Operations

Week 4 of Expedition 361 began with the vessel reoccupying Site U1474 after being pushed off site at 0215 h on 14 February by high winds (up to 58 kt) and a strong current (~2 kt). The vessel arrived back on site at 2000 h on 14 February and the thrusters were lowered at 2024 h.

The drill string was tripped back to the seafloor (3034.3 mbsl) with a center bit installed, and Hole U1474E began at 0725 h on 15 February. The first operation was to drill without coring down to 105.5 mbsf. The center bit was recovered and Cores U1474E-2H to 9H penetrated from 105.5 to 172.0 mbsf using the advanced piston corer (APC) with 105% core recovery. A short interval from 124.5 to 126 mbsf was advanced without coring as requested by the stratigraphic correlation specialists to cover coring gaps.

The half-length APC (HLAPC) was deployed for Cores U1474E-10F to 19F which penetrated from 172.0 to 219.0 mbsf with a core recovery of 99%. The drill string was pulled out of the hole and operations in Hole U1474E ended when the bit cleared the seafloor at 0630 h on 16 February.

The vessel was moved 20 m south of Hole U1474A. APC coring in Hole U1474F started at 0845 h on 16 February and penetrated from the seafloor (3035.9 mbsl) to 190.2 mbsf. After two cores with partial strokes of the APC, the HLAPC was deployed from 190.2 to 238.4 mbsf. The total core recovery at Hole U1474F was 102%. The drill string was pulled from the hole with the bit clearing the seafloor at 0040 h and arriving back on the rig floor at 0745 h on 18 February. The rig was secured for transit and the seafloor positioning beacon was recovered at 0905 h. The thrusters were raised at 0945 h and the sea voyage to our next site (Site U1475; proposed Site APT-01B) began at 0948 h on February 18.

The vessel was underway at full speed for Site U1475 when the Ship's Doctor informed the Captain of a medical emergency requiring evacuation. The ship's heading was changed at 0820 h on 20 February to meet a helicopter for evacuation near Port Elizabeth, South Africa. At ~1200 h on 21 February, the vessel was in position for a helicopter transfer. By 1230 h, the helicopter departed with the patient and the vessel resumed the transit to Site U1475 (APT-01B).

Science Results

Cores from Holes U1474D, U1474E, U1474F, and U1474H have been macro- and microscopically described. Two main lithological units were identified. Unit I is composed of brown foraminifer-bearing clay with nannofossils and is found in the uppermost ~50 cm of each

hole. Unit II is characterized by greenish gray foraminifer-bearing clay with nannofossils alternating with nannofossil-rich clay with or without foraminifers. The nannofossil-rich clay is more common in the deeper cores. Dark gray foraminifer-bearing fine sand layers, ranging in thickness between ~2 cm and 2 m, are common in Unit II. These sandy layers are interpreted to be turbidites although some may prove to be contourites. Green to dark gray mottling and layers of pyrite and glauconite are very common in Unit II. These features are interpreted as bioturbation and diagenetic alteration, respectively. Significant drilling disturbance is observed in the first section of most of the cores and in the base of partial-stroke APC cores.

At Holes U1474E, U1474F, and U1474H, density, velocity, magnetic susceptibility, and natural gamma radiation were measured using the Whole-Round Multisensor Loggers (WRMSL) with a measurement interval of 2.5 cm. Downhole sediment compaction is reflected in decreasing porosity and increasing density with depth. Superimposed on this general trend are physical property changes related to the variable amounts of detrital material. The contrast between the physical property values of fine-grained sediments and silty/sandy intervals allows individual interbedded sand layers to be identified.

Analysis of calcareous nannofossils, planktonic and benthic foraminifers, and diatoms reveals that Hole U1474A spans the Late Pleistocene to the latest Miocene. Calcareous microfossils show good to moderate preservation from 0 to 177 mbsf. Diatoms are not present below the mudline, and sponge spicules, which are present in the upper part of the sequence, disappear below Core U1474A-10H. The biostratigraphy is complete at the biozone level for planktonic foraminifers and calcareous nannofossil and the biostratigraphic datums were refined. The marker species from the genus *Discoaster* are increasingly fragmented and dissolved below 195 mbsf, and reworked specimens from the early Miocene are found between 214 and 254 mbsf. The calcareous nannofossil assemblages are typically tropical to subtropical, with the occurrence of the temperate species *Coccolithus pelagicus* throughout the section. The character of the planktonic foraminifer fauna is similar to those of other western boundary currents, dominated by *Globorotalia inflata* and, in deeper parts of the sequence, by the globoconellid group typical of subtropical convergence zones. Benthic foraminifers occur throughout the entire record in low abundance. The benthic fauna is diverse, includes numerous suboxic components, and the assemblage is typical for a lower bathyal to abyssal environment. Variations in deep-water oxygenation must have occurred throughout the record revealing potential changes in source waters bathing the Natal Valley.

Paleomagnetic and rock magnetic analyses were carried out on sediment cores from Holes U1474C to U1474H. Analyses of discrete samples taken from Hole U1474A indicate that the magnetic mineralogy is dominated by magnetite. The relatively high saturation isothermal remanent magnetization (SIRM) and high and stable S-ratio further reveal that magnetic minerals are well-preserved throughout the sequence. Below ~100 mbsf, an increase of magnetic minerals is expressed by high SIRM. Inclination and declination records were obtained by measuring and demagnetizing the natural remanent magnetization (NRM) of archive core halves and discrete

samples. The inclination record is of good quality and nine polarity zones can be identified. The boundaries of the Brunhes, Matuyama, Jaramillo, Olduvai, Gauss, Gilbert, C3n, and C3r (sub) paleomagnetic chrons constrain the chronology of the sediment cores from Site U1474, and the estimated dates are in good agreement with those suggested by biostratigraphy.

Interstitial water chemistry shows a moderate degree of early sediment diagenesis at Site U1474. Profiles of Mn and Fe indicate suboxic conditions in the upper 5 m of the core. Sulfate reduction occurs throughout much of the sediment column. The overall low organic carbon content, on average below 0.5%, does not support complete removal of sulfate by 250 mbsf and methane concentrations remain at background levels. Carbonate content of the pelagic sediments is moderate, averaging 40%. The sandy layers contain significantly less carbonate than the nannofossil-rich clays. Profiles of conservative elements (K, Mg) downhole suggest either fluid flow or clay mineral alteration reactions at depths below 250 mbsf.

Continuous and distinctive variations in magnetic susceptibility (MS) were used make hole-to-hole correlations among Holes U1474A to U1474F. Confidence in these correlations is high, because they have been cross-checked with the continuous downcore measurements of reflectance (L*) and natural gamma radiation (NGR). A complete affine table to the base of Hole U1474A was constructed to provide tabulated offsets for all cores relative to mbsf. A continuous splice was constructed down to 234 m composite depth (CCSF) using cores from Holes U1474D–U1474F where possible. For some intervals, it was necessary to use sections from Hole U1474A, but sequences in which whole-round samples had been removed were avoided. All sections of disturbed sediment were also avoided for construction of the splice. The contiguity of the splice was confirmed with MS, GRA density, NGR, reflectance, and visual descriptions. Core intervals not included in the primary splice can also be correlated to CCSF using the various data sets.

Education and Outreach

The Education and Outreach program over the past week consisted of live ship-to-shore events and updating social media pages. Seven live video broadcasts were held with five different institutions, reaching an estimated 320 people. The *JOIDES Resolution* webpage (http://joidesresolution.org/), Facebook (https://www.facebook.com/joidesresolution), Twitter (https://twitter.com/TheJR), and Instagram (http://instagram.com/joides_resolution) were updated daily.

Technical Support and HSE Activities

Technical Activities

- Software control of the *P*-wave logger water pump was added.
- The Carver presses for extracting porewater were not maintaining pressure. This issue was resolved by changing the default parameters.

Computing Activities

- The descriptive information capture application (DESClogik) was modified to allow micropaleontology templates with more than 500 species columns to upload.
- The SpliceFileFixer application for stratigraphic correlation was updated and the Site U1474 splice was checked for depth errors.
- The sulfur values, which were uploaded in error, were removed from the CHNS report.
- Nitrate data obtained from a third-party instrument was uploaded into LIMS.

HSE Activities

- The weekly fire and boat drill was held on 15 February.