

## **IODP Expedition 361: Southern African Climates**

### **Week 3 Report (8–14 February 2016)**

#### **Operations**

Week 3 of Expedition 361 began with the vessel steaming to Site U1474 (proposed site NV-02C). The vessel arrived at Site U1474 on 9 February at 2330 h and switched to dynamic positioning mode at 0015 h on 10 February. The 1563 nmi sea voyage from Port Louis, Mauritius, was completed in 5.7 d at an average speed of 11.3 kt.

The precision depth recorder measured the seafloor at Site NV-02C at 3046.7 m below sea level (mbsl). A beacon was deployed at 0342 h and the bottom-hole assembly (BHA) was made-up and spaced out. The BHA, consisting of three stands of drill collars, was assembled and deployed.

The drill string was run to a depth of 3025.2 mbsl. The top drive was picked up and the bit was placed at 3042.6 mbsl for the first APC core. The core barrel was retrieved completely full, missing the sediment-water interface at the seafloor. The bit was raised 7.9 m to 3034.7 mbsl for a second coring attempt. This also yielded a full core barrel. The bit was raised 5 m to 3029.7 mbsl for a third coring attempt at 1525 h on 10 February. This core retrieved a good mudline core.

Cores U1474A-1H through 10H were successfully recovered using the advanced piston corer (APC) to 90.9 m below seafloor (mbsf). While retrieving Core U1474A-10H the core line became jammed in the oil saver sub. Coring resumed after freeing the core line and reheading the cable. Subsequently Cores U1474A-11H to 27H (90.9 to 244.9 mbsf) were retrieved. The total recovery using the APC system is 251.11 m (105%). After four partial strokes using the APC, the half-length advanced piston corer (HLAPC) was deployed for Cores U1474A-28F to 29F (244.9 to 254.1 mbsf). After reaching the HLAPC refusal depth at 254.1 mbsf, the drill string was pulled out of the hole. The bit cleared the seafloor at 1040 h on 12 February, ending Hole U1474A.

The vessel was offset 20 m north of Hole U1474A and coring in Hole U1474B started at 1320 h on 12 February. Cores U1474B-1H to 16H penetrated to 147.3 m and recovered 142.09 m of sediment (96%). One interstitial water whole-round sample was taken from each core section for high-resolution interstitial water geochemistry. After reaching the total depth at 147.3 mbsf, the drill string was pulled out of the hole. The bit cleared the seafloor at 0835 h on 13 February.

The vessel was offset 20 m east of Hole U1474A and coring in Hole U1474C started at 0935 h. Core U1474C-1H was recovered with 3.07 m of sediment. The stratigraphic correlation specialists determined that a longer first core was needed to span stratigraphic gaps. The ship maintained its position and coring started in Hole U1474D at 1100 h on 13 February. Hole

U1474D cored to 124.5 mbsf using the APC system. At 0215 h on 14 February, winds increased to 50 kt, gusting up to 58 kt and, combined with a ~2 kt surface current, led to the dynamic positioning system operating at 100% capacity. We decided to pull the drill string out of the seafloor and wait for weather conditions to improve. The week ended with the vessel waiting on weather.

Thus far at Site U1474, we have cored a total of 529.8 m and recovered 527.18 m of core (100% recovery).

## Science Results

Cores from Holes U1474A, U1474B, and U1474C have been macro- and microscopically described, using digital imaging, multisensor track, smear slide (1–3 per core), and X-ray diffraction (1 per core) data. 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 and 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 are common in Unit II (typically one to three per core), that are interpreted as turbidites, although some may prove to be contourites. Green to dark gray molting and layers of pyrite and glauconite are very common in Unit II. These features are interpreted as bioturbation (burrows and chondrites) 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 U1474A, U1474B, U1474C, and U1474D, density, velocity, magnetic susceptibility, and natural gamma radiation were measured using the Whole-Round Multisensor Logger (WRMSL) with a measurement interval of 2.5 cm. Moisture and density measurements have been performed on 137 discrete samples, predominantly from Hole U1474A. Additionally, 18 thermal conductivity measurements were made in Holes U1474A and U1474B. 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 turbidite 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 nannofossils. 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 to 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 the subtropical convergence. Benthic foraminifers occur throughout the entire record in low abundance. The fauna is diverse and includes numerous suboxic components. The assemblage is typical for a lower bathyal to abyssal environment. Changes in deep-water oxygenation must have occurred throughout the record revealing potential changes in source waters bathing the Natal Valley.

Downcore measurements of natural remnant magnetization (NRM) and the stepwise demagnetized NRM (15, 25 mT) were performed at 4 cm intervals on sediment core archive half sections from Holes U1474A and U1474B. The directional record of NRM carries a coring overprint that was largely removed after demagnetization at 25 mT. In some intervals the directional record is biased by the occurrence of sandy layers and drilling disturbances. Drilling disturbances mainly occur in the upper (Section 1) and lower (Sections 6 and 7) parts of the individual cores. Magnetic data from Cores U1474A-1H to 22H were corrected for their orientation, which was recorded by the IceField tool. The inclination record reveals intervals of dominant normal and reversed polarity that can, in agreement with the biostratigraphy, be assigned to the Brunhes, Matuyama, Gauss, and Gilbert Chrons. Additionally, discrete samples ( $n = 76$ ) that were taken from at least every other section, were subjected to measurements of the anisotropy of magnetic susceptibility (AMS) and NRM demagnetization in six steps (15, 25, 40, 60, 80 and 100 mT). The measurements of the discrete samples verify that for Cores U1474A-1H to 15H the coring overprint was successfully removed from the continuous high-resolution downcore measurements and, therefore, paleomagnetostratigraphy provides a solid basis to develop a high-resolution chronology for records from Site U1474.

The primary activity of the Geochemistry group over the past week was processing interstitial water (IW) samples from Holes U1474A and U1474B. From Hole U1474A, one IW sample was taken from each core from 0 to 200 mbsf and one sample every three cores was taken below 200 mbsf. In total, 26 IW samples were collected from Hole U1474A. Hole U1474B was the designated hole for high-resolution IW sampling. From Hole U1474B, six to eight IW samples were taken from each core to a total depth of ~150 mbsf. Approximately 90 IW samples were collected. All of the IW samples have been squeezed using the Carver presses. The samples from Hole U1474A were analyzed for alkalinity, chlorinity, and nitrate, and additional aliquots are being prepared for analysis of cations by ion chromatography, major and minor elements by inductively coupled plasma atomic emission spectrometry, and phosphate by spectrophotometry. The downcore profile of chlorinity in the IW samples from Hole U1474A shows more scatter than is to be expected from a diffusion controlled system. Interestingly, samples that appear to have anomalously low chlorinity generally coincide with the presence of sandy layers in the sedimentary sequence. The profile of nitrate also displayed an enigmatic distribution, possibly due to the disturbance caused by the sand layers. Aliquots from Hole U1474B have been

packaged for transport for shore-based laboratory  $\delta^{18}\text{O}$  and high precision chlorinity measurements. Additionally, sediment samples collected from Hole U1474A are actively being processed for their organic and inorganic carbon content.

The stratigraphic correlators spent much of the week familiarizing themselves with the *Correlator 2.1* software package, including the flow of data into and out of this software. Holes U1474A and U1474B have been correlated successfully down the full depth of Hole U1474B. The holes were easily correlated through multiple physical properties. However, most of the gaps between cores were aligned in these two holes. Thus, the true compositing of the Site U1474 sedimentary sequence will rely on the acquisition of sediment from subsequent holes that are planned.

## **Education and Outreach**

The Education and Outreach program over the past week consisted of live ship-to-shore events and updating social media pages. Six live video broadcasts were held with five different institutions. 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](http://instagram.com/joides_resolution)) were updated daily.

## **Technical Support and HSE Activities**

### *Technical Activities*

- The magnetic susceptibility loop on the Special Task Multisensor Logger (STMSL) produces a value of zero every 100–200 measurements. A work-around solution has been implemented while we continue to look for the source of the error.
- A new fiberglass boat was installed in the superconducting rock magnetometer (SRM).
- Investigating the cause of two of the Carver presses in the Geochemistry Laboratory failing to maintain pressure when squeezing soft sediment.
- The seismic source for vertical seismic profiles (VSP) is assembled and ready.

### *Computing Activities*

- SampleMaster version 10.5 was deployed.
- Moisture and density (MAD) samples were not appearing in the MADMax work list. This problem was fixed.
- There was a loss of connectivity to the server Cleveland, which hosts access to the Scratch volume. An investigation showed that the server was in the wrong network group. Server access was restored once it was reassigned to the original network group.

### *HSE Activities*

- The weekly fire and boat drill was postponed by one day due to inclement weather.