

## **IODP Expedition 363: Western Pacific Warm Pool**

### **Week 4 Report (23–29 October 2016)**

#### **Introduction**

This week we completed coring at Site U1482 and transited to Site U1483, where we completed coring Holes U1483A and U1483B to advanced piston corer (APC) refusal. At the end of the week we had cored to 262.8 mbsf in Hole U1483C, with a planned total penetration of ~285 mbsf. The scientists completed all analyses of cores from Site U1482 and turned in initial drafts of the Site U1482 report. Analyses of Site U1483 cores are ongoing.

#### **Operations**

##### *Hole U148C*

Position: 15°3.3298'S, 120°26.1135'E

Water depth: 1465.2 m below sea level (mbsl)

Penetration depth: 534.1 m below seafloor (mbsf)

Extended core barrel (XCB) coring in Hole U1482C continued from 447.9 to 534.1 mbsf (Cores U1482C-50X to 60X). Due to very slow penetration rates, Core 59X (7.2 m advance) was pulled after 105 rotating min and Core 60X (6.1 m advance) was pulled after 120 rotating min. Due to poor preservation of microfossils and the increasing length of time to cut cores, we terminated coring operations in Hole U1482C after Core 60X (534.1 mbsf).

We then pumped a 50 barrel mud sweep to remove cuttings from the hole and pumped a go-devil to open the lockable float valve (LFV) in preparation for logging. The top drive was set back and the drill string pulled to set the end-of-pipe at 85 mbsf. The triple combo tool string was prepared and lowered into the drill string at 0443 h (UTC + 8 h) on 24 October 2016. It reached to just above the bottom of the hole and an upward pass was completed before the tool string was retrieved to the rig floor at 1230 h. The Formation MicroScanner (FMS)-sonic tool string was then prepared and lowered into the drill string at 1355 h. The FMS-sonic also reached to nearly the bottom of the hole. The hole was logged with two upward passes to provide increased coverage of the borehole wall with the FMS. The end-of-pipe was raised 15 m at the end of the second run to log that portion of the hole as well. The FMS-sonic tool string was then returned to the rig floor by 2100 h on 24 October. Both tool strings experienced difficulty being pulled through the LFV. After concluding logging operations, the Schlumberger equipment was rigged down and the drill string recovered with the bit clearing the seafloor at 2300 h on 24 October, ending Hole U1482C.

Hole U1482C included 34 APC cores and 22 XCB cores, as well as four drilled intervals (17 m total). We recovered 535.86 m of sediment over 517.1 m of coring, with an average recovery of 104%. Total time on Hole U1482C was 95 h (4.0 d).

#### *Hole U1482D*

Position: 15°3.3305'S, 120°26.0920'E

Water depth: 1466.1 m below sea level (mbsl)

Penetration depth: 213.0 m below seafloor (mbsf)

The vessel was offset 20 m at 230° from Hole U1482A. The drill string was spaced out to 1472 m below rigfloor (mbrf) and Hole U1482D was spudded at 0055 h on 25 October. Core U1482D-1H recovered 4.4 m of sediment, establishing a seafloor depth of 1466.1 mbsl. We then drilled ahead without coring to 137.0 mbsf before continuing to APC core to fill gaps in the composite section. Cores U1482D-3H through 10H penetrated from 137.0 to 213.0 mbsf and successfully recovered cores across the three gaps in the stratigraphy. The drill string was recovered to the rig floor at 1745 h. The positioning beacon was recovered while pulling the drill string and was on deck at 1419 h. After the rig floor was secured, the thrusters were pulled, and the vessel was underway to Site U1483 (WP-11B) at 1800 h on 25 October, ending operations at Site U1482.

Hole U1482D included nine APC cores and one drilled interval of 137.0 m. We recovered 82.77 m of sediment over 80.4 m, with an average recovery of 103%. Total time spent on Hole U1482D was 19 h (0.8 d).

#### *Transit to Site U1483 (proposed Site WP-11B)*

The 142 nmi transit to Site U1483 was completed in 12.5 h at an average speed of 11.4 kt. The vessel began lowering thrusters at 0618 h on 26 October, switching to dynamic positioning control at 0630 h.

#### *Hole U1483A*

Position: 13°5.2382'S, 121°48.2424'E

Water depth: 1732.9 mbsl

Penetration depth: 293.3 mbsf

We deployed the positioning beacon at 0650 h on 26 October. We then prepared and spaced out the bottom-hole assembly (BHA), which consisted of an APC/XCB coring assembly with two stands of drill collars. During deployment of the drill string, the seafloor depth was measured at 1747.4 mbrf with the precision depth recorder (PDR) and we decided to shoot the first core from a depth of 1743 mbrf.

Hole U1483A was spudded at 1250 h on 26 October with Core U1483A-1H recovering 8.6 m of core, establishing a seafloor depth of 1732.9 mbsl. Oriented APC coring with nonmagnetic core

barrels continued to 236.6 mbsf (Core 25H). Downhole temperatures measurements were taken with the Advanced Piston Corer Temperature Tool (APCT-3) on Cores 4H (37.1 mbsf), 7H (56.1 mbsf), 10H (84.6 mbsf), and 13H (113.1 mbsf), obtaining good measurements on three of the four deployments. While retrieving Core U1483A-26H the forward core winch wire parted, leaving the core barrel in the hole. The core winch wire was restrung in the derrick and reheaded. We prepared a fishing spear and lowered it into the drill pipe. The core was retrieved and pulled to surface during the second fishing attempt. After Core 26H was laid out, APC coring continued to 293.3 mbsf (Core 31H), where we encountered a partial stroke, indicating APC refusal and ending Hole U1483A.

A total of 31 APC cores were taken in Hole U1483A. We recovered 308.58 m of sediment over 293.3 m of coring for an average recovery of 105%. Total time on Hole U1483A was 42.25 h (1.8 d).

#### *Hole U1483B*

Position: 13°5.2371'S, 121°48.2538'E

Water depth: 1734.0 mbsl

Penetration depth: 287.0 mbsf

The vessel was offset 20 m east of Hole U1483A, the drill string was spaced out to 1737.5 mbrf, and Hole U1483B was spudded at 0205 h on 28 October. Core U1483A-1H recovered 2.05 m of sediment, establishing a seafloor depth of 1734.9 mbsl. Oriented APC coring with nonmagnetic core barrels proceeded to 287.0 mbsf (Cores 1H to 31H), recovering 301.62 m of sediment (105%). We terminated Hole U1483B just above where we reached APC refusal in Hole U1483A. Total time on Hole U1483B was 25.5 h (1.1 d).

#### *Hole U1483C*

Position: 13°5.2479'S, 121°48.2537'E

Water depth: 1731.2 mbsl

Penetration depth: 262.8 mbsf (as of 0000 h on 30 October 2016)

The vessel was offset 20 m south of Hole U1483B, the bit was set at 1739.0 mbrf, and Hole U1483C was spudded at 0330 h on 29 October. Core U1483C-1H recovered 6.3 m of sediment, establishing a seafloor depth of 1731.2 mbsl. Oriented APC coring with nonmagnetic core barrels penetrated to 262.8 mbsf (Core 28H) by the end of the week. One drilled interval advanced the bit 3 m to offset core gaps for stratigraphic correlation. Cores U1483C-1H to 28H recovered 272.15 m of sediment over 268.2 m of coring (104%).

## Science Results

The sedimentologists finished describing cores from Site U1482 (Cores U1482C-16H through 60X), as well as Holes U1483A (Cores 1H through 31H) and U1483B (Cores 1H through 31H) using a combination of visual core description, microscopic inspection of smear slides, core imaging, spectral color scanning, and magnetic susceptibility. We finalized the Site U1482 lithologic unit division, assigning the entire recovered sequence to lithologic Unit I, with four subunits. Subunit IA consists primarily of light greenish gray nannofossil ooze with foraminifers, pteropods, and variable amounts of clay. The top of Subunit IB marks a transition to more clay-rich nannofossil ooze that includes abundant sulfide specks and nodules. Foraminifers are more abundant towards the bottom of the subunit. Subunit IC is also composed of clay-bearing to clay-rich nannofossil ooze, but shows higher frequency cyclicity visible as color changes from lighter to darker greenish gray that correlate with changes in carbonate content. The top of Subunit ID marks the transition from nannofossil ooze to chalk with lower clay content than the other subunits.

The lithology of Site U1483 is tentatively divided into four subunits based on changes in the relative abundance of biogenic components and clay. The uppermost subunit (IA) is composed of clay- and foraminifer-rich nannofossil ooze. Below this, diatoms become a significant proportion of the sediment, together with clay, in Subunit IB, whereas Subunit IC contains diatoms and foraminifers and subequal proportions of clay and nannofossils. The lowermost subunit has significantly fewer siliceous microfossils and is primarily composed of foraminifer-bearing to -rich nannofossil ooze (Subunit ID). Cyclical changes in color and physical properties appear to track changes in global ice volume.

The biostratigraphers finalized the age-depth model for Site U1482, which shows generally good agreement between the nannofossil and planktonic foraminifer datums, except over limited intervals where some discrepancies occur, which could be a result of calibration issues or the presence of minor hiatuses. Sedimentation rates averaged  $\sim 6$  cm/ky in the late Miocene, decreased to  $\sim 3$  cm/ky in the early Pliocene, and were generally higher ( $\sim 7$  cm/ky) in the Pleistocene.

Similar to Site U1482, the calcareous microfossils at Site U1483 are diverse and well-preserved. Scanning electron microscope (SEM) analyses of foraminifer preservation in Site U1483 is ongoing. Analysis of calcareous nannofossils and planktonic foraminifers from Hole U1483A core catcher samples is complete. The biostratigraphy of Site U1483 is currently being revised using higher resolution sampling in Hole U1483A, with at least three additional samples per core. This approach will provide a direct comparison of nannofossil and planktonic foraminifer bioevents. Initial biostratigraphic data for Hole U1483A indicates higher sedimentation rates compared to Site U1482. Preliminary analysis of planktonic foraminifer and nannofossil data suggests that the age of the sediments in Hole U1483A extends to the early Pliocene. One of the major problems encountered in establishing the age model for Site U1483 is the presence of two

intervals of distinct sediment mixing that contain reworked nannofossil and planktonic foraminifer assemblages. However, biostratigraphic data indicate that we recovered a complete record back to ~2 Ma.

The paleomagnetists completed measurement of the magnetization of archive half sections from Site U1482 on the superconducting rock magnetometer (SRM), and some rock magnetic tests on discrete samples. In Site U1482, natural remanent magnetization (NRM)<sub>15mT</sub> intensity is higher ( $\sim 10^{-4} \text{ Am}^{-1}$ ) in the upper 40–60 mbsf of each hole, decreases between 60–90 mbsf, and remains low ( $\sim 10^{-5} \text{ Am}^{-1}$ ) below ~90 mbsf where it approaches the measurement noise level of the magnetometer. This change is happening simultaneously with decreases in other ferrimagnetic concentration parameters (anhysteretic remanent magnetization [ARM] and isothermal remanent magnetization [IRM]), a halving of the NRM<sub>15mT</sub>/NRM intensity ratio, and a coarsening of magnetic grain size (lower ARM/saturation remanent magnetization [SIRM] ratios). These indicate the reduction of primary ferrimagnetic oxides and formation of secondary iron sulfides during early sediment diagenesis, which is supported by decreases in interstitial water sulfate and the appearance of pyrite in the sediment. Azimuthally corrected declination using the Icefield MI5 tool is largely consistent between adjacent cores, but maintains an absolute offset of 150°–180° (i.e., corrected values for normal polarity cluster between 150°–180° instead of 0°). Relatively weak magnetic susceptibility coupled with reduction of ferrimagnetic oxides results in an uninterpretable signal below the iron reduction zone and restricts our geomagnetic interpretation to the upper 50–70 mbsf. The inclination of the uppermost 70 mbsf reflects expected values for normal polarity (Brunhes Chron) for the site latitude.

At Site U1483, we completed measurement of the magnetization of archive half sections from Hole U1483A on the SRM, and measurement of Hole U1483B is ongoing. The routine measurement of the NRM was performed before and after demagnetization at 15 mT, which was the required maximum peak alternating field to remove the drill string induced overprint. The upper 80 mbsf in Hole U1483A have normal polarity, corresponding to the Brunhes Chron (<0.781 Ma). The sediments between 80 and ~170 mbsf contain several magnetic polarity boundaries corresponding to the Matuyama Chron (>0.781 Ma), the Jaramillo Subchron (0.988–1.072 Ma), and the upper boundary of the Olduvai Subchron (1.778 Ma). Interpretation of the magnetic polarity below ~170 mbsf is difficult because of decreasing intensity. Rock magnetic tests on discrete samples from Hole U1483A are ongoing.

All physical property data have been collected for Site U1482. Additional discrete measurements for thermal conductivity and moisture and density (MAD) were taken in the lower section of Hole U1482C (490–535 mbsf). At Site U1482, the physical parameters display broad scale features and high-resolution cyclicity, which show good agreement with the lithologic subunits defined by the sedimentologists. The effect of increasing compaction at depth is observed on thermal conductivity, gamma ray attenuation (GRA) bulk density, and MAD parameters. GRA bulk density, natural gamma radiation (NGR), and magnetic susceptibility (MS) exhibit a long-

term maximum, centered at ~175 mbsf, coinciding with soft sediment deformation observed in all holes.

Physical property data collection is ongoing for Site U1483, with all measurements completed for Hole U1483A. The *P*-wave measurements, which show consistent values between discrete and whole round data in the upper 70 mbsf, were stopped relatively early compared to Site U1482, as higher methane content at shallower depths in the sediment column caused cracks in the cores that make the data unreliable. The MS and NGR records from Hole U1483A show mostly comparable long-term trends, with distinctive short-term cycles superimposed. Short-term cycles can also be distinguished in the GRA bulk density data; however, the long-term trends are also affected by downhole compaction. Thermal conductivity measurements increase with depth, also associated with the compaction effect.

This week the stratigraphic correlators finished correlation of the four holes at Site U1482. A major focus was to core Hole U1482D specifically to target a few intervals with uncertain correlations around Cores U1482A-22H and 23H to ensure that we have a continuous stratigraphic sequence from about Core U1482A-20H to where we encountered APC refusal at ~345 mbsf. At Holes U1483A, U1483B, and U1483C, we relied heavily on the MS records to correlate between the holes. We had a complete stratigraphic sequence after drilling Holes U1483A and U1483B, although we were unable to correlate between the holes in areas where soft sediment deformation is observed in the cores. We cored Hole U1483C in order to obtain an additional copy of the stratigraphic sequence at Site U1483, and among the three holes we have continuity to develop a robust splice and almost enough to develop a second splice. Currently, we are waiting to obtain the rest of the high resolution GRA, NGR, MS, and L\* data to finalize the splice for Site U1483.

The geochemists finished analyses from Site U1482, which highlight the importance of four processes at the site: organic matter (OM) remineralization and methanogenesis, ion-exchange with clay minerals, secular variations of the carbonate content, and potential carbonate mineral diagenesis. Interstitial water (IW), headspace gas, and solid phase analyses were begun on Hole U1483A. The profiles of hydrocarbon, IW alkalinity,  $\text{PO}_4^{3-}$ , and  $\text{SO}_4^{2-}$  suggest higher OM content compared to Site U1482, with OM remineralization and rapid depletion of sulfate by ~50 mbsf. The OM content will be verified with analysis of total organic carbon weight percent. Initial  $\text{CaCO}_3$  content results show similar secular trends between Sites U1483 and U1482, suggesting that the Quaternary variability of carbonate production and preservation observed earlier at Site U1482 is a regional phenomenon.

We conducted two downhole logging runs in Hole U1482C. The first logging run was with the triple combo tool string, which measures natural gamma radiation, porosity, density, resistivity, and magnetic susceptibility, as well as borehole diameter using a caliper. The triple combo reached to just a few meters off of the bottom of the hole (534.1 mbsf) and collected a single upward logging pass. The Formation MicroScanner (FMS)-sonic tool string was then deployed

into the hole and also reached to nearly the bottom. This tool string also measures natural gamma radiation (for depth matching between logging runs), as well as acoustic velocity and resistivity images of the borehole wall. We completed two upward passes with the FMS-sonic tool string to provide increased imaging coverage of the borehole wall. The logging data were sent to Lamont-Doherty Earth Observatory (LDEO) for processing after logging was completed. The processed data were returned to the ship by the end of the week and will be analyzed next week.

## **Education and Outreach**

The education and outreach officer conducted eight ship-to-shore events. These events reached schools in Brazil, Australia, and four states in the U.S. (California, Missouri, Texas, and Washington). We have also set up a poster competition for schools that have participated in a ship-to-shore event. We have also used Adobe Illustrator to create a comic strip of how seawater changes during an ice age. If this comic is successful, we will develop a second comic strip to illustrate paleomagnetic reversals and how they are recorded in the sediment. We have also posted blogs on the *JOIDES Resolution* website (<http://joidesresolution.org>) as well as posting to Facebook (<https://www.facebook.com/joidesresolution>) and Twitter (<https://twitter.com/TheJR>).

## **Technical Support and HSE Activities**

The following technical support activities took place during Week 4.

### *Laboratory Activities*

- Routine processing of cores and support for laboratories and scientists.

### *HSE Activities*

- An abandon ship and fire drill were conducted on 27 October.