IODP Expedition 369: Australia Cretaceous Climate and Tectonics

Week 5 Report (22–28 October 2017)

Week 5 consisted of coring operations at Site U1513 (proposed Site MBAS-4C) in the Mentelle Basin.

Operations

We began the week cutting Core U1513A-39X to 224.4 m, which was on deck at 0005 h on 22 October. Coring continued from Core 40X to 50X to 292.5 m, the final depth of Hole U1513A. Coring was completed at 1210 h on 23 October. Of the 292.5 m cored, 170.6 m was recovered (58%). Recovery for piston coring (advanced piston corer [APC] and half-length APC [HLAPC]) was 98%, and 39% for cores recovered with the extended core barrel (XCB) system.

After coring finished in Hole U1513A, the hole was prepared for logging with a heavy mud sweep and the drill string was pulled up to 83.9 m. The logging tools were then picked up and assembled. One logging run was planned with the modified triple combination tool string. The tool string contained the Hostile Environment Natural Gamma Ray Sonde (HNGS), High-Resolution Laterolog Array (HRLA), Dipole Sonic Imager (DSI), Hostile Environment Litho-Density Sonde (HLDS), Enhanced Digital Telemetry Cartridge (EDTC), and logging equipment head-q tension (model QT) (LEHQT). The tool string was deployed at 0500 h on 23 October, through the lockable float valve on the APC/XCB bottom-hole assembly (BHA). A successful logging run of the entire open borehole was completed. The logging tools were back on the rig floor at 0950 h and were disassembled by 1130 h.

The drill string was then pulled clear of the seafloor at 1210 h on 23 October, which ended Hole U1513A. The ship was offset 20 m east and Hole U1513B was started at 1425 h. Hole U1513B was intended to fill recovery gaps from Hole U1513A in the Neogene and late Cretaceous sections. Core 1H recovered 8.73 m of material and the seafloor was calculated at 2787.2 m. The first eight cores (1H to 8H) were oriented with the Flexit tool. In situ formation temperatures were attempted with the advanced piston corer temperature tool (APCT-3) on Cores 3H and 5H; however, damage to the APCT-3 on Core 3H discontinued these measurements after Core 5H. While shooting Core 4H, the core liner shattered; thus, it should be noted this is an extremely disturbed core. A partial stroke was recorded for Core 8H, thus coring switched from full-length to half-length APC cores starting with Core 9F. We then recovered Cores 10F to 14F to 98.6 m, which completed coring in Hole U1513B. In total, 102.06 m was recovered from 98.6 m cored (104%). The drill string was pulled clear of the seafloor and Hole U1513B ended at 0625 h on 24 October.

The ship was offset 20 m south and Hole U1513C was started at 0730 h. Only two APC cores (1H and 2H) were recovered to 17.1 m at this hole. All of the material was sampled on the catwalk for use in a postexpedition optically stimulated luminescence (OSL) study.

The drill string was then pulled up to the rig floor by 1645 h on 24 October. In anticipation of heavy weather as well as coring basalt, a four-stand (versus three) rotary core barrel (RCB) BHA with mechanical bit release was assembled and lowered to the seafloor. While lowering the drill string to the seafloor, the ship was offset 20 m west. Hole U1531D was started at 0135 h on 25 October. We drilled without coring to a depth of 95 m and then began coring. We recovered Cores 2R to 15R to 229.4 m. Cores 16R to 19R were half advances (4.8 m) to improve recovery across the Cenomanian/Turonian boundary at ~240 m. We then resumed full-length (9.6 m) coring and recovered Cores 20R to 56R to 603.8 m at 1200 h on 28 October. At this point, the weather forecast was for 9 m swell and winds gusting to 30 kt. Thus, we stopped coring and assembled a free-fall funnel (FFF). We deployed the FFF at 1437 h, and attempted to check the FFF landing and position with the fiber optic vibration isolated television (VIT) camera system, but this was aborted at 700 m due to rough seas and a strong current that pushed the VIT cable against the hull. The VIT was back aboard at 1615 h. The drill string was then pulled up to 139.2 m. As of midnight on 28 October, we are waiting on the weather to improve before resuming coring operations in Hole U1513D.

Science Results

The Core Description team described the lithology of cores recovered from Holes U1513A (from Cores 31X to 50X; 179.5 to 284.69 m CSF-A), U1513B (Cores 1H to 14H; 0 to 98.57 m CSF-A), and U1513D (Cores 2R to 52R; 95 to 565.4 m CSF-A). The recovered sediments at Site U1513 are divided into five lithostratigraphic units (Unit I through V) based on macroscopic core description, microscopic examination of smear slides and thin sections, and X-ray diffraction (XRD)/X-ray fluorescence (XRF) analyses. Unit I is a 64.9 m thick sequence of light gray to pale yellow calcareous ooze and nannofossil ooze with sponge spicules that are late Miocene–Pleistocene in age. At the bottom of Unit I, a 13 cm thick bed of brownish yellow calcareous ooze (hardground) with abundant ferromanganese oxide nodules, apatite nodules, and zeolitic clay marks the sharp boundary between Units I and II. This hardground is most evident in Section U1513B-8H-2 (64.80–64.93 m CSF-A). Unit II is a 182.9 m thick sequence of Cenomanian–Campanian white to greenish gray calcareous and nannofossil ooze that gradationally transitions into nannofossil chalk and clayey nannofossil chalk. Unit II is subdivided into Subunits IIA and IIB based on the presence of chert nodules and beds of silicified limestone. Unit III consists of 21.9 m of alternating green, light gray, and black nannofossil-rich claystone that is Cenomanian in age. At the top of Unit III, a distinctive thin bed (<10 cm) of black organic-rich claystone with sharp bottom and top contacts was recovered in Sections U1513A-45X-2 (245.13–245.19 m CSF-A) and U1513D-19R-2 (246.26–246.36 m

CSF-A). Unit IV is a 187 m thick sequence of black claystone that is Albian–Cenomanian in age. Unit V (present in Hole U1513D below Core 41R) is a sequence of glauconitic sandstone interbedded with siltstone and claystone. The sandstone is classified as volcanic-rich with lithics visible in thin section.

The Micropaleontology team analyzed core catchers and selected interval samples from Holes U1513A, U1513B, and U1513D. We established a biostratigraphic and paleoecological framework and refined planktonic foraminiferal and calcareous nannofossil biostratigraphy datums for Site U1513. Hole U1513A covers the Pleistocene to late Miocene, lying unconformably on a succession of Campanian to mid-Cenomanian. Hole U1513B spanned the same Neogene succession as Hole U1513A, but recovered a hardground containing a mixture of early Miocene to latest Cretaceous microfossils. Below this hardground, the succession consisted of lower Campanian to Santonian material. Sediment recovered from Hole U1513D represents a Santonian to Albian interval to Core 41R. Below this core, the material is barren of all nanno- and microfossils. The Cenomanian/Turonian boundary was identified in Core 19R. Biostratigraphically significant planktonic and selected calcareous and agglutinated benthic foraminiferal taxa were documented with scanning electron microscope (SEM) micrographs.

The paleomagnetic measurement program encompassed the detection of the remanent magnetization of archive-half sections of Cores U1513B-1H through 14F before and after 10 and 20 mT alternating field demagnetization and of Cores U1513D-1R through 54R at 0, 10, 20, and 30 mT AF demagnetization. The Flexit core orientation tool was deployed in conjunction with Cores U1513B-1H though 8H recovered with the APC system. The upper ~65 m of Hole U1513B exhibit a stable magnetic component, which allows for the determination of magnetic polarity of the recovered sediments. A complete magnetostratigraphic sequence from the Pleistocene into the late Miocene (C1n through C3r) was identified. Below the unconformity (hardground), between ~65 and 110 m CSF-A, significant scatter of both normal and reverse intervals prohibits a definite assignment of magnetic polarity, although based on biostratigraphic evidence it most likely represents Chron C33r (lower Campanian). The RCB cores of Hole U1513D display predominantly normal polarity downcore to 462 m CSF-A, representing Chron C34n. Reverse polarity chrons below 462 m CSF-A can currently not be assigned with confidence to the polarity timescale because of the lack of biostratigraphic control.

The Geochemistry team analyzed 51 samples from Site U1513 on the coulometer and elemental analyzer, and 26 on the source rock analyzer. Total organic carbon content was generally low (<1.5%), except in a black claystone in Section U1513D-19R-2 near the Cenomanian/Turonian boundary, which contained up to 10% TOC. Source rock analysis indicates a predominantly marine source for the organic matter. Forty-four samples (every ~10 m) have been analyzed for interstitial gas as part of the routine safety monitoring program, with only trace amounts of methane detected.

Thus far, 31 samples from Hole U1513D have been taken for interstitial water analysis, with a focus in the upper part of the hole of filling in gaps from Hole U1513A (Cores 2R to 23R) before resuming a sampling resolution of one IW sample per core downhole from Core 24R, as possible. Salinity, pH, and alkalinity have been measured on all IW samples. Alkalinity is relatively low for these samples and decreases downhole, with a drastic drop to values less than 1 after Core 43R. Salinity is slightly higher than seawater, and pH increases slightly below Core 46R. All Hole U1513A samples (n = 24) have been analyzed on the inductively coupled plasma–atomic emission spectrometer (ICP-AES), ion chromatograph (IC), and for ammonium; Hole U1513D samples from 6R to 32R have been analyzed on the IC to date.

The Petrophysics group completed core-based analyses and downhole logging of Hole U1513A at the beginning of the week. Work then shifted to recording the physical properties measurements of Hole U1513B (Cores 1H–14F) and Hole U1513D (Cores 2R–56R). Data from Holes U1513B and U1513D were combined with Hole U1513A to generate a more comprehensive physical property record of Site U1513. In Hole U1513D, the data show relatively low natural gamma radiation (NGR) values for Cores 2R–18R, with a relatively abrupt increase in values in Core 19R that corresponds with the Cenomanian/Turonian Boundary interval. The values decrease again downhole to Core 28R, followed by maximum NGR values for the Hole in Cores 40R and 41R. The NGR values then decrease sharply between Cores 41R and 42R. This decrease in the NGR signal with increasing depth corresponds well to a sharp increase in magnetic susceptibility (MS) data and is coeval with a minor increase in bulk density values. Presumably, this is due to the decrease in clay and a shift to the sandstone and interbedded siltstone and claystone intervals. The physical properties boundary observed at Core 41R marks a sharp increase downhole in *P*-wave velocities from 1900 to 2400 m/s. Values decrease to 2000–2200 m/s in Core 43R. Between Cores 24R and 41R, the porosity decreases with depth from 57% to 45%.

At Site U1513, two holes used for the stratigraphic correlation of the upper succession were cored with the APC/HLAPC system to 95.7 m CSF-A (Hole U1513A) and 98.57 m CSF-A (Hole U1513B). Target depths that would place core breaks in Hole U1513B within well recovered intervals in Hole U1513A were formulated prior to drilling and adjusted based on recovery and physical properties of the recovered material. After coring, physical property records were compared and a core composite depth below sea floor (CCSF) depth scale was constructed for the overlapping portions of Holes U1513A and U1513B. Tiepoints were based mainly on sharp peaks within broad trends in NGR with color reflectance data providing additional constraints. The presence of similarly distinctive peaks in wireline logging NGR records from Hole U1513A permitted translation of core depth scales from CSF-A to WMSF (wireline matched depth below seafloor).

Coring also overlapped from ~95 to 293 in Hole U1513A (XCB coring) and Hole U1513D (RCB coring). To assist the coring strategy of Hole U1513D, the wireline logging data and the lithologic information from Hole U1513A were evaluated to identify intervals with high

resistivity and hard lithologies, such as silicified limestone and chert, and used to predict areas of low recovery in Hole U1513D. It was also used to target the Cenomanian/Turonian boundary interval, the recovery of which is a major objective for the expedition. Recovery in Hole U1513D was good to excellent across much of the lower Turonian and upper Cenomanian, an interval of recovery plagued by large coring gaps in Hole U1513A. A tentative splice was constructed for the upper Cenomanian to lower Turonian interval, from 234.0 to 271.6 m CSF-A in Hole U1513A and from 229.4 to 271.8 m CSF-A in Hole U1513D, based mainly on color reflectance, MS, and NGR data, and refined by matching sedimentary stacking patterns apparent in core images. The suggested correlation of Cenomanian–Turonian strata across Holes U1513A and U1513D requires further testing by comparison to final biostratigraphic and chemostratigraphic data, as well as wireline logging information.

Education and Outreach

We conducted seven live interactive events this past week with schools in Brazil for their national Week of Science and Technology. These broadcasts reached approximately 128 children. On 26 October at 1850 h in Brasília, a five-minute prerecorded live event was broadcast on the Brazilian channel Band Cidades; it featured interviews with Alice Plakoudi (IODP representative in Brazil), Brian Huber, Rodrigo Guerra, and Cristiane Delfina, and focused on Expedition 369, the *JOIDES Resolution,* and life aboard the ship.

On social media, there were eight posts to Facebook (https://www.facebook.com/joidesresolution; total of 933 likes/comments and shares), nine new posts on Twitter (https://twitter.com/TheJR; 116 total likes and 46 retweets), 12 posts on Instagram (http://instagram.com/joides_resolution; 599 total likes and 11 new followers for 809 total followers), and three new blogs for the *JOIDES Resolution* website (http://joidesresolution.org). We ran a contest on Facebook asking people to send in name suggestions for a dinoflagallete character, and the promotion of four foraminifera illustrations made by an invited professional artist increased the engagement of the followers and the feedback about the posts.

Individual projects included creating geological-themed fabric designs, finishing new coloring packets to be made available on the http://joidesresolution.org website, and finishing three columns for the Brazilian web portals CAPES and *Jornal da Unicamp*.

Technical Support and HSE Activities

Activities of the technical team mainly revolved around supporting the science party and laboratories while coring. Specific activities included the following.

Site U1513 Coring and Core Handling

- One of the formation temperature tools (APCT-3) was damaged during an attempt to use it during Core U1513B-3H.
- Processed and sectioned both cores from Hole U1513C (1H and 2H) for OSL samples. The cores were cut into 30 cm whole-rounds on the catwalk and immediately placed into opaque bags for storage.
- Cores potentially spanning an Oceanic Anoxic Event in both Holes U1513D and U1513A were specially wrapped with O_2 absorbers and O_2 barrier shrink wrap film, and flushed with argon.

Laboratory Activities

- The aft touchscreen monitor for the Whole-Round Multisensor Logger was acting strangely; the mouse would start to move around on its own, and sometimes randomly click on an object. Further observation and investigation is in progress.
- Hand-held XRF:
    - We initially experienced some hiccups with file downloading (data were lost); however, this issue was solved with further training and the affected core sections were rescanned.
    - We started to see an error message on the handheld XRF that might indicate a failing component; we are in contact with the vendor.

I.T. Activities

- Provided general help desk support for staff and science party.
- Set up and issued an IODP loaner laptop to a scientist whose personal laptop is not working.
- Installed new software for the towed magnetometer on Winfrog1 and Winfrog2 for evaluation by the technical staff.
- Installed a new video card in the Core Tech shop computer.
- At the request of the chemistry technicians, installed ICP software (without license keys, demo mode only) on the ChemLab tech station and both Microbiology stations.
- Reinstalled the license for the TechLog software on one of the logging workstations after it appeared to somehow have been deleted.
- Resolved several issues with Windows 10 security settings and the ability to install/run IODP software, including MUT, DESClogik, and Image Capture.

HSE Activities

- Safety showers and eye wash stations were tested.
- The weekly boat drill was held on 24 October.