IODP Expedition 369: Australia Cretaceous Climate and Tectonics

Week 4 Report (15–21 October 2017)

This week consisted of transit to Site U1513 (proposed Site MBAS-4C) in the Mentelle Basin and coring operations in Hole U1513A.

Operations

We were originally underway to proposed Site MBAS-4B in the Mentelle Basin, offshore southwestern Australia. On 15 October, the decision was made to core an alternate site (proposed Site MBAS-4C) instead, as it was postulated to contain an expanded Cretaceous sedimentary section and a slightly shallower basalt target. Our course was adjusted with no time lost and the transit covered 795 nmi in 3.7 d with an average speed of 9.1 kt.

The ship started reducing speed at 1418 h on 18 October, with the thrusters down and the sea voyage over at 1442 h. The acoustic positioning beacon was deployed at 1510 h. Preparations were then made for coring with the advanced piston corer (APC) and extended core barrel (XCB) systems; the APC/XCB bottom-hole assembly (BHA) was made up, and included a lockable float valve for wireline logging and a nonmagnetic drill collar. A used (33.3 h) drill point 11-7/16 inch C-3 (SN DB294) coring bit was attached to the bottom of the BHA. The Icefield tool was used for core orientation. Nonmagnetic APC core barrels and standard XCB core barrels were used. Hole U1513A was started at 0340 h on 19 October. The first core recovered 5.3 m establishing a seafloor depth of 2789.2 mbsl.

APC Cores 1H to 6H penetrated to 52.8 m with 97% recovery. Due to the expected presence of chert layers, as reported from DSDP Site 258, a switch was made to the half-length APC (HLAPC) to recover Cores 7F and 8F to 62.2 m. No chert was found, but there were some manganese nodules in the cored material. The APC system was then used again to recover Cores 9H and 10H to 80.6 mbsf. At this point, partial strokes of the APC and obvious signs of core flow-in occurred, so we switched to HLAPC coring. Cores 11F to 15F penetrated to 95.7 m with 97%. However, Core 15F only advanced 0.10 m with over 3000 psi, indicating that we had reached piston coring refusal. We switched to XCB coring on 20 October, and Core 16X was recovered to 98.7 m. The presence of interbedded chert layers reduced the average rate of penetration to 10 m/h, with as low as 1.5 m/h in the chert layers. The alternating chert and relatively softer intervals also reduced core recovery significantly (to <50%). To maximize the material recovered and to periodically check the condition of the XCB cutting shoe, we began cutting half cores (~5 m advancements) from Core 20X (127.5 m). As of midnight on 21 October, Core 39X was being cut at 224.4 m. Seven cutting shoes have been retired because of missing or damaged tungsten carbide cutters while taking the first 24 XCB cores thus far.

Science Results

The laboratory teams spent the first part of the week completing the Site U1512 reports and the latter part of the week working on the initial cores from Hole U1513A.

Cores 1H to 9H are characterized by intervals of pale brown and white calcareous ooze with sponge spicules. A number of manganese nodules are also present in Cores 7F and 8F (52.8–62.62 m CSF-A). From Core 10H, recovery drastically declined and coincided with the appearance of chert nodules. Between Cores 10H to 25X (71.7–149 m CSF-A), the lithology is a pale white nannofossil ooze with pale yellow irregular chert nodules. Cores 25X to 31X (154–182 m CSF-A) show a transition to more lithified white nannofossil chalk, with intervals of silicified limestone. Bioturbation is also more prominent in this lithology with planolites, thalassinoides, chondrites, zoophycos, and teichichnus ichnofacies. Based on smear slide observations and XRD measurements, glauconite and clay content increases between Cores 24X and 31X.

The biostratigraphy team spent several days writing the Site U1512A report, which included scanning electron microscope (SEM) analyses of all microfossil groups identified and uploading all data to DESCLogik for the site. Sedimentary core catchers from Cores 1H through 38X at Hole U1513A have been analyzed. Calcareous nannofossil and planktonic foraminiferal datums form the framework of the age model. Cores 1H to 7F range from the upper Pleistocene to upper Miocene. Core 8F is interpreted as a hardground with abundant manganese-phosphate nodules and calcareous nannofossil and planktonic foraminiferal assemblages ranging from Miocene–Eocene. This unconformably lies on a thick hemipelagic succession of lowermost Campanian through the Turonian. All microfossil groups are present throughout, but there are low abundances of foraminifera in Cores 32X to 38X. However, planktonic foraminifera, where present, give ages consistent with those derived from calcareous nannofossils. Benthic foraminiferal assemblages contain a few agglutinated and more commonly calcareous forms indicative of open marine, well-oxygenated environments at bathyal paleodepths. Radiolaria, sporadic inoceramid prisms and very rare organic-walled dinoflagellate cysts also occur through this succession.

The remanent magnetization of archive-half sections of Cores 1H through 36X was measured before and after 10 and 20 mT alternating field demagnetization. The Icefield core orientation tool was successfully deployed in conjunction with Cores 1H through 6H. Despite a relatively weak magnetic signal and a drill string overprint, a relatively stable magnetic component was preserved in sediments down to ~89 m CSF-A, which allows for the determination of magnetic polarity for some parts of the recovered sediment sequence. We tentatively identified the magnetostratigraphic sequence from the Pleistocene into the upper Miocene (C1n through C3Ar) from the seafloor to ~64 m CSF-A. The normal polarity interval below 64 m CSF-A has been tentatively assigned to Chron 33n (Campanian) based on biostratigraphic evidence. Significant

directional scatter in the XCB-cored section below 95 m CSF-A prohibits the assignment of magnetic polarity without the analysis of discrete samples.

The geochemistry team finished analyzing samples from Site U1512 on the coulometer, elemental analyzer, and source rock analyzer. These data were included in the Site U1512 report. From Hole U1513A, 37 samples have been analyzed for interstitial gas as part of the routine safety monitoring with only trace amounts of methane detected. A total of 26 samples have been freeze-dried and crushed and will be used for bulk geochemistry analysis with the coulometer and elemental analyzer. Fifteen interstitial water (IW) samples were collected; incomplete recovery and the presence of chert/lithified carbonates have prevented sampling from every core. Thus far, salinity, pH, and alkalinity have been measured on the IW samples, with further batch analyses to be done shortly. Alkalinity seems to be low for these samples and slowly decreasing further downhole. Salinity is slightly higher than seawater, and pH is unremarkable.

The Petrophysics and Stratigraphic Correlation teams compiled results from Site U1512 and then completed a revised Site U1512 report. In the upper interval of Hole U1513A, Cores 1H to 4H preserve well-defined fluctuations in natural gamma radiation (NGR) counts with higher values appearing to correspond to darker Quaternary-aged sediments. Although U and Th contents are very low, deconvolution of the NGR signal shows that these cycles correspond to U/Th cycles, which may indicate nitrification cycles. With initial age control from biostratigraphic data, they may correspond to the 405 ky eccentricity cycle. In Cores 6H to 9H, NGR and gamma ray attenuation (GRA) density values increase upcore in two ~10 m thick packages. Anomalously low GRA density in Cores 10H and 14F (<1.5 g/cm^3) indicate significant drilling disturbance. We have recovered occasional broken XCB cutting shoe teeth (e.g., Cores 16X and 19X). However, it is possible that additional, smaller pieces avoided detection and influenced magnetic susceptibility and density readings on the Whole-round Multisensor Logger. There is no indication that the teeth affect the NGR results, but to be certain, we examined the bulk chemistry of the teeth using the handheld XRF. The results of these analyses showed that the teeth have very low concentrations of U, Th, and K, suggesting that any contamination is unlikely to influence the NGR measurements. Low (<50%) core recovery below Core 16X precluded continuous measurement of physical properties. Nonetheless, there is stability among the NGR (4–8 counts/s) in the recovered material. Additionally, a test of the consistency of measurements on the NGR logger run at 300 s compared with the standard 600 s found similar results. This method modification could enable us to more rapidly process incoming whole rounds of core during subsequent periods of piston coring.

Education and Outreach

We conducted five interactive events this past week with schools in Brazil, the United Kingdom, and the Smithsonian Institution in Washington, D.C.

Individual project work included a series of embroidered depictions of foraminifera and editing for new educational coloring pages for educators. A photography series called "Postcards from the scientists" has been started, and additional articles with scientific content are in production. A video series featuring women in science is being edited, and a podcast for Brazilian audiences is in production. Finally, a video titled "Seismic methods made simple" was produced and is intended as a post for the Brazilian newspaper *Jornal da Unicamp* and for the CAPES portal.

On social media, there were nine posts to Facebook (https://www.facebook.com/joidesresolution; total of 668 likes/comments, and 37 shares), seven new posts on Twitter (https://twitter.com/TheJR; 46 total likes and 18 retweets), seven posts on Instagram (http://instagram.com/joides_resolution; 385 total likes and 10 new followers for 798 total followers), and three blogs for the *JOIDES Resolution* website (http://joidesresolution.org). The Facebook statistics show that the activities on the *JOIDES Resolution* page grew by 300% from last week, page views were up 21%, post engagement increased 186%, and the number of videos viewed increased 329%. These figures possibly show a result to the exposure from the BBC World News interview.

Technical Support and HSE Activities

Activities of the technical team mainly revolved around maintenance activities during the transit from Site U1512, receiving cores at Hole U1513A, and supporting the science party and laboratories while logging core. Specific activities included the following.

During Transit

- Attempted to tow the magnetometer and discovered communication issues from the towfish. Initially, it communicated, but the signal kept stopping after a few minutes. We recycled the power multiple times, and the signal still stopped after 3–10 min. Upon further investigation of the towfish, we decided to replace its electronic module, which solved the problem. The "broken" electronic module will be shipped back at the end of the Expedition, and the vendor will repair it.
- Updated the new Seaspy software ("BOB") for the towed magnetometer. Further testing is continuing. We will update the user guide once testing is complete.
- Tried to install the new X-ray diffraction software, but this was unsuccessful. Communication with vendor (Bruker) was intermittent. As a result, we reverted back to the old software, but may try again if there is another coring/sampling break.
- Protected species watch training was provided to all assigned staff.
- Provided further detailed DESClogik training for the Micropaleontology team.

At Hole U1513A

- Currently preparing the seismic source for scheduled vertical seismic experiment which may happen in the deep RCB hole, Hole U1513D.

Miscellaneous Activities

- Check out sheets for most of the storage area and laboratories were updated.
- Levelwind was repaired.
- Replaced the printer in the Underway Geophysics Laboratory (UWGL) because the printer display was not working.
- The metal step into the UWGL was found to be corroded; it was replaced by the ship's crew.

I.T. Activities

- Provided general help desk support for staff and science party.
- Replaced the National Instruments serial box on Winfrog2.
- Moved the microbiology Zebra printer in the Chemistry Laboratory.
- Resolved an issue with Winfrog in creating ship position files. The issue was with screen resolution and caused by the Laboratory Officer's system. For future reference, the resolution should be set at 1680 × 1050.
- The belt for the auxiliary AX system in the data center broke; Siem Offshore staff were able to repair it.
- Uninterruptable power supply tests were conducted by Siem Offshore staff.
- Assisted the Ship's Doctor in resolving a connectivity issue with the telemedicine system.
- Changed the printer configuration on the three Hewlett Packard 855 color printers so that it would properly notify the Marine Computer Specialists about low toner and other issues.

HSE Activities

- Safety showers and eye wash stations were tested.
- The weekly safety drill was held.