IODP Expedition 369: Australia Cretaceous Climate and Tectonics

Week 3 Report (8–14 October 2017)

The third week of Expedition 369 consisted of operations at the Expedition's first site, Site U1512 (proposed Site WCED-4A) in the Great Australian Bight. This site consisted of rotary core barrel (RCB) coring and logging operations in one hole, Hole U1512A, to a total depth of 700 m.

Operations

Week 3 of Expedition 369 commenced with RCB coring at 19.2 m in Hole U1512A and the recovery of Core 3R. Coring continued throughout the week with excellent recovery, averaging 90% for the entire hole. During coring and subsequent analysis of the cores, it became evident the intervals were more expanded than expected, suggesting that the original seismic velocity model was incorrect. After adjusting the depth estimates, permission was sought and received to deepen the target depth of the hole from 570 to 700 m. RCB coring continued through the recovery of Core 73R to 700.8 m at 1915 h on 13 October, which completed coring operations at Site U1512. In total, 73 RCB cores were retrieved with 631.86 m of material recovered from 700.8 m cored (90%).

After releasing the RCB bit at the bottom of the hole and bringing the drill pipe up to logging depth (69.9 m), a modified triple combination tool string was assembled with the following tools: Hostile Environment Natural Gamma Ray Sonde (HNGS), High-Resolution Laterolog Array (HRLA), Dipole Sonic Imager (DSI), Hostile Environment Litho-Density Sonde (with source) (HLDS), Enhanced Digital Telemetry Cartridge (EDTC), logging equipment head-q tension (model QT) (LEHQT), and a centralizer for centralizing the DSI and the HRLA. In this modified tool string, the HNGS was moved to the bottom of the tool string and the DSI was added from the Formation Micro-Scanner (FMS) tool string. The tools were assembled, tested, and deployed at 0435 h on 14 October. A downlog was performed from just above the seafloor to 698.4 m. The hole was then logged up for a short calibration pass (~100 m), run back to the bottom, and logged up to just below the end of the drill pipe, where the caliper was closed prior to reentering the drill pipe. The tools were pulled from the hole and were back at the surface at 1130 h, and by 1345 h on 14 October the equipment was rigged down.

The drill string was then pulled out of the hole, clearing the seafloor at 1410 h. The acoustic beacon was released and recovered on deck at 1736 h. At 2255 h on 14 October, the end of the drill pipe cleared the rig floor. The rig floor was secured for transit at 2300 h, ending Hole U1512A and Site U1512.

As of midnight on 14 October, the vessel was underway to Site U1513 (proposed Site MBAS-4C). The estimated time of arrival is 0600 h on 18 October.

Science Results

The core description group described the lithology of each core from Hole U1512A. The first two cores (Cores 1R and 2R) are characterized by intervals of pale brown and white calcareous ooze with sponge spicules that abruptly changes to a dark gray biosiliceous silty clay in the middle of Section 2R-6 (~10 m CSF-A). Dark silty clay extends to about the bottom of Core 8R (~76 m CSF-A) where it gradually transitions into a dark gray silty claystone by Core 10R (~86 m CSF-A), the dominant lithology throughout the rest of the hole. Important lithologic features included numerous ~10–15 cm thick siltstone and sandstone layers. The composition of the sandstones is variable with some being dominated by glauconite and others containing an abundance of sand-sized siderite. These were noted in visual core descriptions and confirmed with X-ray diffraction (XRD) and handheld X-ray fluorescence (XRF) analyses. Bioturbation and discrete burrows are also common in several intervals with the burrows occasionally filled with fine-grained pyrite. Shelly clam fragments, including frequent occurrences of inoceramids, are common from Core 4R to the bottom of the hole. Biogenic components, including foraminifera, calcareous nannofossils, siliceous cysts, sponge spicules, and radiolarians, were present throughout most of the recovered interval; however, their abundance was variable.

The biostratigraphy team analyzed all sedimentary core catchers. The calcareous nannofossil team also evaluated additional samples taken from the middle of working-half core sections. Calcareous nannofossil datums form the framework of the age model for Hole U1512A as they are most consistently present. Planktonic foraminifera are rare, and where present, give ages consistent with those from calcareous nannofossils. Core 1R is in calcareous nannofossil Zone CN15 and planktonic foraminiferal Zone Pt1b, and is upper Pleistocene/Holocene in age. This unconformably lies on a thick hemipelagic succession of lowermost Campanian/upper Santonian through the Turonian (nannofossil Zone CC11 at the base of the hole), characterized by sparse and sporadic occurrences of foraminifera and calcareous nannofossils. Tubular agglutinated forms dominate benthic foraminiferal assemblages. Radiolaria and dinoflagellate cysts also occur through this succession.

The remanent magnetization of archive-half sections of all RCB cores were measured after 0, 10, and 20 mT (Cores 1R through 5R) and after 0, 10, 20, and 30 mT alternating field demagnetization (Cores 6R through 73R). Shipboard analyses conducted so far suggest that a stable and useful magnetic signal is preserved in this hole. Paleomagnetic split-core measurements of the heavily biscuited top of the section (0–80 m CSF-A) reveal an expectedly noisy signal that might be improved with discrete samples taken from the undisturbed RCB biscuits. Below 80 m, preliminary comparison with biostatigraphic data and consistently negative (normal) magnetic paleoinclinations suggest the recovery of the Cretaceous Normal

Superchron C34n in Cores 9R through 73R. A short magnetic excursion is recorded between 256 and 259 m CSF-A. Paleomagnetic directions from discrete samples to resolve the top 80 m and for comparison with the split-core results are currently being conducted.

The geochemistry group completed the majority of the standard suite of analyses for the site. Overall, 46 interstitial water (IW) samples were taken, at a resolution of one per core from Cores 1R–36R and 55R–57R, every other core from Cores 44R–54R, and one final sample from Core 59R. No IW samples were taken after Core 59R. This sampling pattern was dictated by the low IW volume yield from the dark claystone samples. Pore waters from the lowermost samples of the hole could only be retrieved by using the small squeezing device, which exerts higher internal pressure. In addition, some IW analyses could not be performed due to the low yield; priority was given in those cases to inductively coupled plasma–optical emission spectroscopy (ICP-OES) and IC analyses. The sulfate–methane transition zone (SMTZ) is located at about 100 m CSF-A (Cores 10R and 11R), and was initially identified by a peak in alkalinity (up to 17 mM). Analysis of additional elements via ICP-OES and ammonium using spectrophotometry are still in progress.

Samples for headspace gas analysis (n = 73) were generally taken adjacent to the IW samples. These were analyzed for low molecular weight hydrocarbons using gas chromatography. The methane content increases below the SMTZ (up to ~100,000 ppm), and in places the methane:ethane ratio suggests the presence of thermogenic gas. Additionally, 72 samples were taken for bulk sediment analysis from the IW squeeze cake or from the working-half core section when no IW sample was taken. Using the coulometer, 59 of these samples have been analyzed to date for carbonate content, and for carbon and nitrogen content using the elemental analyzer. In general, the carbonate content of Core 1R (pale brown and white calcareous ooze with sponge spicules) is ~90 wt%. The dominant lithology for the hole, a dark silty clay(stone), only contains an average of about 2 wt%. Total organic carbon is surprisingly low, averaging 0.75 wt% for the dark silty claystone lithology.

The physical properties and stratigraphic correlation teams collected measurements using the Whole-Round Multisensor Logger, Natural Gamma Radiation Logger, *P*-wave velocity caliper, and discrete sampling. Multisensor *P*-wave measurements below Core 11R were discontinued due to poor contact between the core sections, their liners, and the caliper. Natural gamma radiation (NGR) values range from 10.0 to 49.3 counts/s, with an average of 32.8 counts/s. Gamma ray attenuation (GRA) values range from 1.4 to 3.3 g/cm^3 with an average of 1.7 g/cm^3. Magnetic susceptibility (MS) values range from –0.59 to 253.58 IU (International Units) with an average of 9.35 IU. GRA values in siltstone/claystone do not exceed 2.2 g/cm^3, while in siderite nodules and glauconitic sandstones, GRA values increase up to 3.28 g/cm^3. MS values of claystone and siltstone do not exceed 16 IU, but suddenly increase up to 253.58 IU in the glauconitic sandstone and siderite. At scales longer than 10 m, the NGR and MS records do not correlate over silty/clayey intervals from Cores 3R to 15R, possibly because of the high abundance of pyrite differentially influencing the MS values. The NGR and GRA records display

parallel trends in this interval. From Core 16R to 62R, pyrite abundance markedly decreases and all three data types (MS, NGR, and GRA) display similar trends. From Core 63R to 73R, both the NGR and the MS values decrease, while GRA remains stable, possibly due to higher compaction of claystone with depth. At shorter scales (<10 m), MS, GRA, and NGR show high-amplitude cycles of 3–5 m thickness from Cores 10R to 19R, Cores 34R to 43R, and Cores 62R to 73R. The range of *P*-wave velocities in the silty claystone range from 1670 to 2346 m/s, although faster velocities (3397–5774 m/s) were obtained for the discrete layers of sideritic sandstone. High resolution (2 cm) reflectance spectroscopy and colorimetry data from archive-half core sections display high-amplitude variability. However, due to the homogeneity of the lithology and the color (grey-black), the long-term reflectance signal remains stable.

On average, three moisture and density (MAD) samples were taken from each core. An additional MAD sample was occasionally collected to obtain a measurement from the non-representative bands of sideritic sandstone. Overall, the MAD results show that density increases and porosity decreases downhole. The range of dry bulk densities obtained for the dark silty claystone are 1.54–2.37 g/cm^3 and the density of the sideritic sandstone units range from 3.21–3.49 g/cm^3. The porosities obtained for the silty claystone are 28%–50%, with most measurements between 40%–48%. The porosity of the sideritic sandstones range from 5%–13%.

A downhole logging run with one tool string was conducted in Hole U1512A on 14 October 2017. A modified 44.48 m long triple combination tool string was used to measure formation density, natural gamma ray, resistivity, and sonic velocity. Continuous logging along the full depth of the open borehole generated comparable trends to the corresponding core-based physical property measurements, such as NGR counts over long (>100 m) and short (<10 m) depth intervals. Raw logging data were sent to shore for processing and we expect the processed data to be returned next week.

Education and Outreach

We had a total of four live interactive events during this past week with schools and museums in Brazil, Morocco, and the USA. There was also a live 3 min long interview on BBC World News with one of the Co-Chief Scientists (Brian Huber) about the Expedition's scientific objectives; an additional follow-up 10 min prerecorded interview was broadcast on BBC World Service Radio.

Furthermore, a Q&A video series was developed with some of the Ship's crew and catering staff answering questions from preschool and elementary school students. Very positive feedback was received from several of the teachers who participated in the broadcasts and who watched the videos produced last week.

On social media, there were seven posts on Facebook (https://www.facebook.com/joidesresolution; total of 540 likes/comments), six new posts on Twitter (https://twitter.com/

TheJR; 83 total likes and 31 retweets), eight posts on Instagram (http://instagram.com/joides_resolution; 308 total likes and 21 new followers for 788 total followers), and two blogs posted to the *JOIDES Resolution* website (http://joidesresolution.org). The Facebook statistics show that the activities on the *JOIDES Resolution* page grew by 50% from last week, page views were up 4%, postengagement increased 14%, and the number of videos viewed increased 189%. Over the past month, the *JOIDES Resolution's* Twitter statistics show the number of profile visits and mentions have increased by 129% and 102%, respectively. The *JOIDES Resolution's* Twitter handle has also added an additional 72 followers.

Technical Support and HSE Activities

Activities of the technical team mainly revolved around receiving Site U1512 cores and supporting the science party and laboratories while logging core. Specific activities were:

- Processed cores from Hole U1512A for a total of 73 RCB cores (90% recovery). No H_2S was encountered.
- The Section-Half Multisensor Logger (SHMSL) MS probe was found to be loose, and was not making contact with split-core surfaces. Assisted the science party with rescanning Cores 37R to 57R after adjustments were made.
- Supported the use of the handheld XRF on both split-core sections and discrete samples (from XRD powders).
- In the Chemistry Laboratory, all four elements in the ashing furnace (for loss on ignition) were replaced, and the temperature was increased to the desired setting without any delay.

Miscellaneous Activities

- Three wheels on the core carts failed, and a request to shore will be sent by Monday.
- Had trouble running the site fix (for official site position Hole U1512A) on the remote computer in the technical office as it kept crashing Winfrog. Fugro gained remote access into the Winfrog computer in the Underway Geophysics Laboratory, but was able to run the site fix with no problem. They then noticed the resolution on the remote PC in the technical office is higher than on the Winfrog PC, which caused a data processing delay and resulted in crashing Winfrog. After adjusting the resolution on the remote PC, this resolved the issue.

I.T. Activities

- Provided general help desk support for staff and science party.

- Installed new XRD software and had the host talking to the instruments, but could not start D4Tools. Reverted back to the old instrument host and attempted to contact Bruker for help—a second attempt will be made at a later date.
- Moved the Microbiology Zebra printer in the Chemistry Laboratory.
- Changed the monitor resolution on several PCs in the Core Laboratory to allow DESCLogik to be displayed correctly.
- The new version of the CaptureOne software was not working correctly on the close-up PC, so the old version was reinstalled.
- Helped troubleshoot the site fix issue with WinFrog.

HSE Activities

- Safety showers and eye wash stations were tested.