IODP Expedition 369: Australia Cretaceous Climate and Tectonics

Site U1513 Summary: Return for basement coring and logging

After originally operating at Site U1513 from 18 October to 2 November, we returned to Site U1513 at the end of Expedition 369 (1) to recover basalt from deeper in the sequence and (2) to collect additional wireline log data. We summarize these new operations and science here; results from the previous visit to Site U1513 are available at http://iodp.tamu.edu/scienceops/sitesumm/369/369_ss1513.html.

Background and Objectives

IODP Site U1513 had the following objectives: (1) to obtain a continuous late Cretaceous sediment to improve the record of the rise and fall of the Cretaceous Hot Greenhouse climate at southern high latitudes; (2) to characterize how oceanographic conditions changed during the Cenozoic opening of the Tasman Passage and the restriction of the Indonesian Gateway; and (3) to obtain basalt from the base of the sedimentary sequence to provide stratigraphic control on the age and nature of the pre-Gondwana breakup succession. A particularly important goal was to obtain a complete oceanic anoxic event (OAE) 2 sequence across the Cenomanian/Turonian boundary (CTB).

Operations

We occupied Site U1513 on two different occasions. Earlier in the expedition (18 October–2 November), we conducted coring in four holes (U1513A, U1513B, U1513C, and U1513D) and logging in two (U1513A and U1513D). Hole U1513D penetrated into and recovered the underlying basalts with coring from 690.2 to 757.4 m. In both Holes U1513A and U1513D, a modified triple combination tool string, measuring density, downhole sonic velocity, resistivity, and natural gamma radiation (NGR) was deployed. The logs from Hole U1513A spanned 83.9 to 289.8 m, and logs from Hole U1513D covered 146.3 to 346 m. Overall, 14.4 d were originally spent at Site U1513.

We returned to Site U1513 on 20 November after a 4.1 h transit from Site U1516. Hole U1413E (33°47.6190′S, 112°29.1204′E) was started at 1040 h. The hole was drilled down to 685.2 m. The center bit was pulled and Cores 2R and 3R were recovered to 704.4 m. The center bit was again dropped and drilling without coring began again. However, we had difficulty making progress, so the center bit was pulled after advancing 21.6 m and coring resumed. Cores 5R through 9R were recovered to 774.0 m. Coring terminated at 1615 h on 22 November. In total, seven rotary core barrel (RCB) cores were taken, recovering 49.99 m from 67.2 m cored (74%). The hole was circulated twice with high viscosity mud, and the bit was released to the bottom of the hole. The hole was then displaced with heavy mud. The drill pipe was pulled up to 426 m.

A modified triple combination tool string, consisting of a hole locator, 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 two centralizers for the DSI and the HRLA, was assembled and deployed at 0305 h on 23 November. The tool string reached 325 m, and was unable to pass the top of the drill collars in the bottom-hole assembly (BHA). The tool string was pulled back to the rig floor by 0710 h and was investigated. There was no obvious malfunction in the tools nor apparent obstruction in the drill pipe, so we could not determine why the tool string was unable to exit the pipe. We then assembled the versatile seismic imager (VSI) tool string for the seismic experiment. The VSI consists of the versatile seismic imaging tool (VIST), HNGS, EDTC, and the LEHQT. The VSI was deployed at 0925 h on 23 November. The marine mammal and diving sea bird watch was started at 1100 h, 30 min prior to initiating use of the seismic source. Two 250 inch G-type air guns were lowered to 7 m below sea level (hydrophone at 9 m) and ramped up softly to 2,000 psi. The VSI encountered an obstruction at 637 m. The survey was started there, and stations were held every 25 m from the bottom of the hole. The final check shot was at 250 m (inside the pipe). The VSI was completed at 1605 h.

Because of the issue running the modified triple combination, we first checked the drill pipe by running a core barrel to approximately 400 m twice. This was a very good indication pipe and BHA were clear of obstructions. The modified triple combination was again assembled, but without the hole locator, and deployed at 2110 h. We were able to log from the end of the pipe to an obstruction at 614.0 m. The logging run was completed at 0215 h on 24 November. We then assembled the Formation MicroScanner (FMS) tool string with Accelerator Porosity Sonde (APS). Specifically, it contained the microelectrical scanner tool (MEST), downhole toolbus adapter (DTA), HNGS, EDTC, and the LEHQT. The tool string was deployed at 0440 h. Two logs were completed from the end of the pipe to 611.0 m by 1020 h, then the tool string was disassembled.

We then pulled the drill string up to 119.3 m. The final logging run for Hole U1513E was with the traditional configuration of the triple combination tool string, with the HRLA, HLDS, APS, HNGS, EDTC, LEHQT, and two centralizers. The tool string was deployed at 1425 h and the hole was logged to 610 m, where an obstruction was encountered. The tools were back on the rig floor at 1930 h, and dissembled by 2130 h. The drill string was then brought up to the rig floor at 0525 h on 25 November, ending Hole U1513E. The total time spent on the hole was 5.1 d.

We once again tried to recover the acoustic positioning beacon at this site, but the beacon would not release when commanded. As before, it appeared to register the command, but would not release. The beacon was left behind.

Principal Results, Hole U1513E

Lithology

The cored section at Site U1513 is divided into six lithostratigraphic units, five sedimentary and one igneous, based on a combination of data from Holes U1513A, U1513B, U1513D, and U1513E. The igneous Unit VI was first recovered in Hole U1513D and more extensively recovered in Hole U1513E. Some fall-in material from the reddish-brown siltstone of Unit V was observed in the top of Core U1513D-66R. This interval was recovered in Hole U1513E and shows a sharp boundary between Units V and Unit VI. Combining the recovery of the unit from Holes U1513D and U1413E, Unit VI has a total recovered thickness of 82.2 m. The top of the unit is defined by a flow top breccia with an altered matrix that grades downsection into a massive plagioclase-phyric basalt flow. The unit is composed of five extrusive sequences intercalated with four volcaniclastic breccia beds that show graded structures and are defined as Lithologic Units 1–7. Each extrusive sequence is generally bounded by chilled margins, but also by faults, or textural and color changes. Most discrete flows appear to be massive, thin sheets of olivine ± pyroxene- or plagioclase-phyric (some megacrystic) basalt. The least altered portions of the lowermost sequence (Unit 7) show a higher degree of vesicularity and highly angular vesicles that may indicate subaerial to very shallow eruption depths. A xenolith-bearing diabase dike intrudes the flow sequences in Cores U1513D-67R to 74R and Cores U1513E-2R to 6R. The contact between the xenolith-bearing diabase dike and the extrusives are defined by either faulted or chilled margins with alteration halos. In contrast to Hole U1513D, flows recovered in Hole U1513E show a lesser degree of alteration, and preliminary megascopic and thin section analyses reveal the original porphyritic, microcrystalline, or vesicular textures, with some of the bottom flows showing interesting cross-cutting lineation features and absent to minor intrusion intervals.

Biostratigraphy and Micropaleontology

No samples for micropaleontology were analyzed.

Paleomagnetism

The natural remanent magnetization (NRM) of all archive-half core sections of Hole U1513E (Cores 2R, 3R, and 5R through 9R), corresponding to the basalt material from Lithostratigraphic Unit VI, were measured. The archive halves were stepwise treated with up to 20 or 30 mT alternating field (AF) demagnetization and measured with the pass-through superconducting rock magnetometer (SRM) at 5 cm intervals. Paleomagnetic results are comparable to results obtained from the same depth interval from Hole U1513D. The NRM intensity is strong, ranging from 2.6×10^{-6} to 13 A/m with a mean of 1.4 A/m. The magnetic susceptibility is very high, ranging from 0 to 5000 IU, with a mean of 740 IU.

Petrophysics

Physical property data from Hole U1513E were obtained with the Whole-Round Multisensor Logger (WRMSL), Natural Gamma Radiation Logger (NGRL), *P*-wave velocity caliper, and Section Half Multisensor Logger (SHMSL). These data are comparable to the lowermost unit of Hole U1513D (Lithostratigraphic Unit VI). The indurated breccia and crystalline rocks of Unit VI showed spikes in MS and density, along with nearly undetectable counts of NGR. In the overlying sedimentary sequence (Units I–V), trends in porosity and caliper *P*-wave velocity measurements demonstrated a gradual but occasionally punctuated change to lower and higher values, respectively.

Downhole logging was conducted in Holes U1513A, U1513D, and U1513E using several downhole tool configurations. This included the modified triple combination tool string, measuring NGR, density, sonic velocity, and resistivity, as well as the traditional triple combination, FMS-APS and VSI at some intervals in Hole U1513E. Measurements of NGR, density, and resistivity from each hole yielded similar results for the overlapping depth intervals across Holes U1513A, U1513D, and U1513E. The most continuous downhole logging run using the triple combo occurred in Hole U1513E and spanned from a bridge at ~615 m WMSF to the bottom of the drill pipe at ~119 m WMSF. The wireline logging data provided continuous coverage and filled several coring gaps. The most striking features included a strong positive response in resistivity, density, and sonic velocity values through intervals of silicified limestone (96–123 m and 152–180 m WMSF; Lithostratigraphic Unit II), and a shift from low to high NGR across the CTB interval (~240–245 m WMSF). NGR increased downhole from this horizon through the Cenomanian–Albian claystones, displaying similar trends to NGR of core from the site. In situ temperature measurements were attempted from Hole U1513B, but this experiment returned only one reliable measurement of 4.55°C from Core 5H.

Geochemistry

No geochemical analyses were performed.

Stratigraphic correlation

No stratigraphic correlation was performed.