IODP Expedition 371: Tasman Frontier Subduction Initiation and Paleogene Climate

Site U1510 Summary

Background and Objectives

International Ocean Discovery Program (IODP) Site U1510 (proposed Site LHRS-3A; 36.3290°S, 164.5587°E, 1250 m water depth) is on the southern Lord Howe Rise, ~850 km west of northern New Zealand and ~495 km south of DSDP Site 206. Site U1510 is ~80 km west of DSDP Site 592 and ~105 km northwest of DSDP Site 207. Seismic reflection data can be used to tie stratigraphy at these three sites, but with some uncertainty caused by unconformities and deformation. Site U1510 was chosen to determine the timing of Cenozoic folding on the southern Lord Howe Rise, and to constrain the timing of regional tectonic movements and volcanism. The primary drilling objectives at Site U1510 were: (a) to constrain the depths and ages for the top and base of the syntectonic seismic unit; (b) to determine the nature of the lowest seismic unit and pretectonic state of the southern Lord Howe Rise; and (c) to collect evidence for volcanism or vertical movements, especially including sediments representing nearby shallow water of any age. A secondary objective was to collect a continuous late Neogene record for paleoceanographic studies.

Operations

Hole U1510A (36°19.7385'S, 164°33.5220'E, water depth 1238 m)
Hole U1510B (36°19.7392'S, 164°33.5347'E, water depth 1239 m)

After the 380 nmi transit in heavy winds and seas from a waiting on weather location, the ship arrived at Site U1510 at 0918 h on 12 September 2017.

An advanced piston corer (APC)/extended core barrel (XCB) bottom-hole assembly was deployed, and coring in Hole U1510A started at 1915 h on 12 September. Cores U1510A-1H through 17H penetrated from 0 to 150.5 m DSF and recovered 147.9 m (98%). We stopped deploying the orientation tool after Core U1510A-15H. Temperature measurements were taken on Cores 4H, 7H, 10H, 13H, and 17H. We continued with XCB coring until 1930 h on 14 September. Cores 18X through 52X penetrated from 150.5 to 483.4 m DSF and recovered 108.1 m (32%). Recovery over portions of this depth interval was compromised seriously because of frequent chert layers. Coring in Hole U1510A concluded on 14 September with a total penetration of 483.4 m DSF and total recovery of 260.0 m (53%). The time spent on Hole U1510A was 60 h or 2.5 d.

The ship was offset 20 m to the east and APC coring in Hole U1510B began at 2300 h on 14 September and ended at 0215 h on 15 September. Cores U1510B-1H through 7H penetrated from 0 to 66.3 m DSF and recovered 64.7 m (98%). An APCT3 temperature measurement was taken on Core 7H. Operations at Hole U1510B and at Site U1510 ended at 0815 h on 15

September. The time spent on Hole U1510B was 10.75 h or 0.4 d. At 0842 h the ship began the transit to Site U1511 (proposed Site TASS-2A).

Principal Results

All depth references in meters refer to the depth scale type CSF-A, unless noted otherwise.

Lithostratigraphic Unit I (0–138.0 m) is composed of calcareous ooze with subtle color banding in the uppermost 33.4 m. The boundary between Unit I and Unit II is defined by the first occurrence of chert at 138 m.

Lithostratigraphic Unit II (138.0–418.1 m) consists of ~340 m of calcareous ooze and chalk interbedded with cherty limestone and chert. Unit II is divided into three subunits. Subunit IIA is a ~9.5 m thick white homogenous nannofossil ooze with bioclasts. The upper ~30 cm of Subunit IIA consist of centimeter-sized extraclasts composed of chert, cherty limestone, and lithic clasts. Although this interval could be affected by drilling disturbance (i.e., "fall-in" at top of core), it also contains the first occurrence of chert, and similar material had not been found in the cores above. Subunit IIB (147.5–349.4 m) is a 201.9 m thick interval of light gray, moderately bioturbated clayey calcareous chalk with scattered shallow water bioclasts, interbedded with cherty limestone. Subunit IIC (349.4–478.1 m) is a 128.7 m thick homogenous white nannofossil chalk interbedded with chert and sparse volcaniclastic beds in the lower portion of the subunit.

Core recovery in Unit I was near 100%, with coring disturbance limited to uparching and soupy sediments. Recovery dropped to ~20% in Subunits IIA and IIB due to the presence of chert and cherty limestone and the use of the XCB coring system, with drilling disturbance including severe fracturing of chert and cherty limestone intervals and moderate to severe biscuiting of the calcareous chalk intervals.

Nannofossils are generally abundant with moderate preservation. Planktic foraminifera abundance and preservation decrease downhole (from 215 m and 187 m, respectively) with a few barren samples. Radiolaria are rare throughout except for a short middle Miocene interval (109.6 to 119.7 m) where the preservation is good. Benthic foraminifera were recovered with generally low abundance from all cores, with very good preservation for the Neogene and generally poor preservation for the Paleogene. Paleodepth was lower bathyal from the Pleistocene through the Eocene. During the late and middle Eocene a significant component of the benthic fauna appears to be derived from shallower (shelf, upper bathyal, middle bathyal) sources. Ostracods are very abundant in most samples with good preservation from 0 to ~150 m, and with poor preservation below. Due to weather constraints on processing, no samples from Site U1510 were analyzed for palynology.

Based on nannofossil and foraminifera biostratigraphy, the following ages were determined for the sequence in Hole U1510: Pleistocene (5.0–33.5 m), Pliocene (43.1–70.3 m), Miocene (72.3–

135.4 m) and late, middle, and early Eocene (138.8–147.7 m, 150.5–438.9 m, and 448.9–478.2 m, respectively).

Low intensity of natural remanent magnetization of most cores, low core recovery, and significant core disturbance from XCB coring make it difficult to establish shipboard magnetostratigraphy at Site U1510.

Physical property measurements show a gradual increase in bulk density and *P*-wave velocity with depth in the nannofossil and foraminiferal ooze of Unit I. In Subunits IIA and IIB, from 140 to ~350 m, physical property measurements are less reliable and sparse due to drilling disturbance and low recovery, respectively. Bulk density (~1.75 g/cm^3) and *P*-wave velocity (~1750 m/s) increase downhole to 300 m, then decrease again to the base of Subunit IIB, where fewer chert layers are observed. Magnetic susceptibility and natural gamma radiation (NGR) both increase downhole in these two subunits, then decrease towards the base of Subunit IIB. *P*-wave velocity peaks and spikes in NGR in Subunit IIc correlate with sandstone and claystone. Near the base of the hole (~470 m), where sediments become more lithified, density and velocity increase and porosity decreases.

Headspace samples from Site U1510 yielded hydrocarbon gas concentrations below detection limit. A total of 118 interstitial water (IW) samples were taken from Site U1510 by squeezing whole-round sediment and by Rhizons. Concentrations of Ca increase and Mg and K concentrations decrease downhole, similar to Sites U1506 and U1507. These profiles may result from the reaction of pore water with volcanic material in the sediment. Sulfate and ammonium concentration profiles mirror each other, suggesting sulfate reduction of organic matter. Dissolved Sr, Si, Li, and B concentrations increase downhole, likely reflecting dissolution of biogenic carbonate and silica. Dissolved Mn and Fe concentrations decrease within the uppermost meter, suggesting the true mudline is missing. Dissolved Fe concentrations in Rhizon samples decrease rapidly over the upper 8 to 10 m, consistent with the smell of H_2S at ~10 m.

Carbonate content is >90% in Unit I as well as in Subunits IIA and IIC, corresponding to calcareous ooze and chalk lithologies. In Subunit IIB, carbonate content decreases downhole towards the middle of the subunit, along with decreasing L* and increasing NGR. Interbedded cherty and tuffaceous layers are distinguished by carbonate contents of <50% and <20%, respectively. Total organic carbon content is mostly below detection limit, but represented by somewhat higher values (0.35%) below 400 m.

Coring of U1510B was monitored in near real-time through out-of-sequence measurement of whole-round sections. Using primarily NGR data, cores from Holes U1510A and U1510B were depth-shifted to construct a composite depth scale. A spliced record was generated using the composite scale, which provides a continuous record of the top ~44 m of sediment at Site U1510.