

IODP Expedition 356: Indonesian Throughflow

Site U1458 Summary

Background and Objectives

Site U1458 lies in the northern part of the Perth Basin, adjacent to the Houtman-1 industry well on the northern Rottneest Shelf (James et al., 1999; Collins et al., 2014). The site is directly seaward of, and downdip from, the Houtman-Abrolhos main reef complex, which contains the most southerly tropical reefs in the Indian Ocean. The evolution of this reef complex is directly related to the path of the Leeuwin Current. Dating of sediments cored at Site U1458, coupled with seismic correlation, was anticipated to provide insight into the pre-Quaternary history of these reefs and a long-term perspective on Leeuwin Current evolution at the tropical/subtropical boundary off western Australia. In addition, it was suggested that subsidence rates over the last 140 k.y. were low compared to those of the reefs of the Carnarvon Basin (Collins and Testa, 2010). Subsidence analyses of the shelf wedge drilled at this site could have allowed more precise modeling of dynamic subsidence along the western margin of Australia. Finally, any finer grained facies in this section may have yielded a Pliocene–Pleistocene record of the onset and variability of the southern Australian winter-dominated rainfall regime.

Unfortunately, we were unable to effectively core and recover the coarse-grained sediment encountered at Site U1458 and the site was abandoned in favor of an alternate (Site U1459; proposed site NWS-13A), located ~1 nmi seaward of Site U1458 and in water ~50 m deeper, where it is hoped that a finer grained section will be encountered. As a result of the poor recovery and shallow penetration, paleomagnetic data was not produced at this site and no discrete samples were taken. Downhole logging and stratigraphic correlation were also not attempted.

Operations

Site U1458 (28°39.85'S, 113°34.67'E) consisted of a single hole (U1458A). The original plan called for three advanced piston corer (APC) holes to refusal with two of these holes advanced to 330 m with the extended core barrel (XCB) system. It became immediately apparent during operations at Hole U1458A that the APC system would not penetrate the surface formation. After two attempts with the APC system, one with the XCB system and one with the half-length APC (HLAPC) system, coring was abandoned at Site U1458.

Preparations were then made to proceed to a deeper alternate site. The total time spent on Site U1458 was 24.25 h.

A total of four cores were recorded for the site, penetrating to a total depth of 10 mbsf. Cores U1458A-1H and 2H recovered 1.05 m and 2.12 m of material, respectively. Core 3X recovered no material and Core 4F recovered only 0.55 m. Because we advanced by recovery, the overall recovery for Site U1458 was 37%.

Principal Results

Lithostratigraphy

Site U1458 yielded a total of 3.72 m of core. The material recovered in all cores was normally graded due to sorting of the sediment within the core liner during coring and recovery. The poor recovery and potential reworking of sediments limited information for defining lithologic units, so only lithology was described.

The core recovered at Hole U1458A suggests a hard seafloor comprising a ~10 cm thick lithified layer, with a soft sediment cover in the mudline sample. The sediment below the lithified layer is unlithified skeletal grainstone to rudstone containing coarse rhodolith-bearing gravel to fine-grained carbonate sand. Diverse macro- and microfossil assemblages found in diminishing order of abundance were rhodoliths, mollusk fragments, bryozoans, calcareous and siliceous sponge spicules, and benthic and planktic foraminifers. Smear slide analyses indicate that the rudstones are predominantly composed of skeletal fragments of mollusks and bryozoan colonies. The occurrence of well rounded to ellipsoidal gravel to coarse sands indicates moderate-energy currents in the area.

Biostratigraphy

Three core catchers were sampled from Cores U1458A-1H, 2H, and 4F. Core U1458-3X did not yield any core catcher material. In addition to foraminifera and nannofossils, bryozoans, ostracods, and pteropods were found. One key planktonic foraminifera species (*Globorotalia tosaensis*) was identified, which provides an age for the base of Core U1458A-2H of ~0.61 Ma. A mudline sample was also taken from this site.

Nannofossils

Calcareous nannofossils were observed in core catchers from Cores U1458A-1H, 2H, and 4F, and the mudline sample. The abundance of calcareous nannofossils is very low.

Calcareous nannofossil preservation is poor to good. The youngest biostratigraphic event occurs in the mudline sample and is based on the occurrence of *Emiliana huxlei*. The estimated age is <0.29 Ma, or NN21. Section U1458A-1H-CC contains a Recent-Pleistocene assemblage with Neogene Reticulofenestrids that were likely reworked. From the base of Core 1H to the bottom of the hole, Gephyrocapsids are very common with a dominance of *Gephyrocapsa caribbeanica*. Based on Gephyrocapsids and *G. caribbeanica* in the samples, the estimated age at total depth is <1.73 Ma.

Planktonic Foraminifera

The samples contained between 12%–66% planktonic foraminifera and the preservation varied between poor and intermediate. In Section U1458A-2H-CC, around 10% of specimens were reworked. There was evidence of diagenesis and inorganic precipitation and/or recrystallization in Section 4F-CC. The overall diversity was low with around five or six different species in each sample. *Globigerinoides ruber* (white); *Globigerinoides conglobatus*; *Globigerinoides sacculifer* (without sack); *Globorotalia crassaformis*; *Globorotalia menardii*; *Globorotalia tosaensis*; and *Neogloboquadrina dutertrei* were encountered. *Globorotalia tosaensis* is reported to be ~0.61 Ma, according to Mix et al. (1995). The specimens of this species did not appear to be reworked. Thus, unless they were transported from the slope, this marker species gives a rough age of ~0.61 Ma at the base of Core 2H.

Benthic Foraminifera

The samples contained between 35%–88% benthic foraminifera, dominated by *Quinqueloculina lamarckiana* and *Amphistegina lessonii* and abundant *Cibicidoides bradyi*. Eleven to 23 species were encountered in each sample. Preservation was poor and fragmentation varied from poor to very poor. Encrustation and heavy abrasion on tests impeded some identification down to species level, indicating reworking. Section U1458A-1H-CC contained temperate, shallow water foraminifera.

Geochemistry

Three samples were analyzed for headspace gas content, which showed very low subsurface methane (<2.5 ppm). Inorganic and organic carbon content and interstitial water geochemistry measurements were not conducted.

Physical Properties

Physical property measurements at Site U1458 were collected using the multi-sensor logger, natural gamma ray (NGR), *P*-wave velocity caliper, and discrete sampling. Gamma ray attenuation bulk density averaged 1.33 g/cm³ in the APC cores (1H and 2H) and 1.59 g/cm³ in the HLAPC core (4F). The average magnetic susceptibility was 0.66 SI and two peaks were observed at 1.1–1.4 m and 9.5–9.7 m. Low NGR counts and low GRA bulk density occur together and correspond to the coarser rudstone, and vice versa for the carbonate sands. These trends may be due to lithology variations or to loss of water in the pore spaces of the coarser materials. *P*-wave velocity measurements were performed on the sandier portions of Cores 1H, 2H, and 4F, and fluctuated between 1500 and 1800 m/s. The color reflectance was measured on the archive halves of the split cores and did not show any clear trends. One MAD sample was taken in each of cores 1H, 2H, and 4F. MAD bulk densities had the same values as corresponding GRA bulk densities and MAD grain densities did not vary. Cores 1H and 2H have higher porosity (~55%) than that of Core 4F (47%).

Disturbance that occurred during drilling and coring resulted in the sorting of the materials. Generally, the material becomes coarser downcore. However, cemented rudstones occurred at the tops of the cores. The physical properties reflect these changes in sediment size. However, we do not believe that these variations have stratigraphic significance.

References

- Collins, L.B., and Testa, V., 2010. Quaternary development of resilient reefs on the subsiding Kimberley continental margin, Northwest Australia. *Brazilian Journal of Oceanography*, 58: 67–77.
- Collins, L. B., James, N. P. and Bone, Y, 2014. Chapter 19 Carbonate shelf sediments of the western continental margin of Australia. *In: Continental Shelves of the World: Their Evolution During the Last Glacio-Eustatic Cycle*, eds. F. L. Chiocci and A. R. Chivas, Geological Society, London, Memoirs 2014, v.41; p255–272.
- James, N.P., Collins, L.B., Bone, Y., and Hallock, P., 1999. Subtropical carbonates in a temperate realm: modern sediments on the southwest Australian shelf. *Journal of Sedimentary Research*, 69(6): 1297–1321.

Mix, A.C., Pisias, N.G., Rugh, W., Wilson, J., Morey, A., and Hagelberg, T.K., 1995. Benthic foraminifer stable isotope record from Site 849 (0–5 Ma): local and global climate changes. *In* Pisias, N.G., Mayer, L.A., Janecek, T.R., Palmer-Julson, A., and van Andel, T.H. (Eds.), *Proc. ODP, Sci. Results*, 138: College Station, TX (Ocean Drilling Program), 371–412.