

IODP Expedition 356: Indonesian Throughflow

Week 1 Report (31 July–8 August 2015)

The first week of IODP Expedition 356 (Indonesian Throughflow) consisted of port call, scientist introduction and orientation, and operations at two sites (U1458 and U1459). Operations at Site U1458 were completed after a single day and Site U1459 was started.

Operations

Expedition 356 officially began at 0800 h on 31 July 2015 alongside the Victoria Quay (Berth C) in Fremantle, Australia, with IODP technical staff, the Expedition Project Manager, and the Co-Chief Scientists boarding the vessel. All public relation activities were concluded on 31 July. The remainder of the science party boarded the vessel on 1 August, and the loading of drilling equipment, expedition stores, and food were completed. The vessel was then made ready for sea passage. On 3 August, the pilot arrived on board at 1545 h and at 1615 h the last line was released. With assistance from two harbor tugs, the vessel proceeded to the pilot station and the pilot departed the vessel at 1634 h. The 237 nmi sea voyage continued for 24.25 h and ended at the expedition's first site, U1458 (proposed site NWS-6A). The average speed for the voyage was 11.1 kt. After arriving on location on 4 August, the thrusters were lowered and the dynamic positioning (DP) system was engaged.

Site U1458 (proposed site NWS-6A)

The advanced piston corer (APC)/extended core barrel (XCB) bottom-hole assembly (BHA) was picked up, assembled, lowered to the seafloor, and all preparations were made to begin coring. During the first core barrel run, the coring line failed. Fortunately, the break was between the crown and the top drive and we were able to secure both ends and then recover the wireline and core barrel. The core line was restrung and ~700 m of core line was slipped and cut from the coring winch drum. After ~6 h of time to repair the parted coring line, we attempted to take the first core of Hole U1458A. While there was evidence that the core barrel had slightly penetrated the seafloor, there was no core recovered. Hole U1458A was finally spudded at 0300 h on 5 August. The mudline core recovered 1.05 m of sediment and seafloor was calculated to be 156.7 m below sea level (mbsl). Non-magnetic core barrels were used for APC coring from Core U1458A-1H. Orientation was attempted starting with Core U1458A-1H. At 3.1 m below seafloor (mbsf), the formation became too hard to piston core and an XCB core barrel was deployed; Core U1458A-3X penetrated 6.3 m but without any recovery. The half-length APC (HLAPC) was then deployed and recovered only 0.55 m. After experiencing high torque and a stuck pipe during connections, we decided to abandon Site U1458 in favor of an alternate site. The coring equipment was rigged down and the top drive was set back. The drill pipe was pulled back to the rig and the BHA was secured. The acoustic positioning beacon was recovered at 1415 h and the rig was secured for transit. Hole U1458A ended at 1425 h (5 August) when the rig was secured

for transit. The dynamic positioning system was used to transit to Site U1459 (proposed site NWS-13A).

Two APC piston cores penetrated only 3.1 m and recovered 3.17 m of core. The HLAPC was used once and recovered 0.55 m of core. The single XCB core penetrated 6.3 m without recovery. Overall core recovery for Hole U1458A was 3.72 m recovered from 10.0 m cored (37%). The total time spent at the site was 24.25 h.

Site U1459 (proposed site NWS-13A)

After the 1 nmi transit from Site U1458, we offset 75 m to the west of the Site U1459 coordinates, deployed an acoustic beacon at 1553 h on 5 August, and began drill floor activities. On the first APC core barrel run, the core barrel came back empty. The depth of the bit was repositioned and the second core barrel made contact with the seafloor, but the core barrel failed at the center threaded connection. The HLAPC core barrel was then prepared. The bit was lowered to tag the seafloor (192 mbsl) and the core barrel was fired into the stiff formation. Hole U1459A was spudded at 1920 h and Core U1459A-1F recovered only 0.01 m. After determining that the seafloor was too firm for either the APC or HLAPC system, the XCB system was picked up and deployed.

An XCB core barrel was dropped and a 9.6 m interval was penetrated, recovering only 0.63 m of core in 120 rotating minutes. Unfortunately, to make the next drill pipe connection to continue coring deeper in these poor hole conditions, the bit had to be raised above the seafloor. After re-drilling and then coring an additional 3.7 m to ~13.5 m, hole conditions once again forced us to pull above the seafloor. To allow us to make the next connection while keeping the bit in the hole, we replaced the 30 ft knobby with two joints of drill pipe and then drilled ahead without coring to 13.4 m. The connection was made, re-installing the 30 ft knobby, and coring continued with the XCB system (Cores U1459A-3X to 5X) to 32.1 m with poor recovery. An increased penetration rate indicated that the hard formation had given way to something appropriate for the HLAPC. The HLAPC was picked up and Cores U1459A-6F and 7F recovered 2.89 m and 0.46 m of sediment, respectively. After recovering Core 7F, another hard layer was encountered (at 34.9 mbsf). The XCB core barrel was again deployed and advanced 2.5 m without recovery. Below this hard layer, the HLAPC was deployed and Cores U1459A-9F to 14F penetrated to 70.3 m with excellent recovery (average 92%). The core barrel containing Core U1459-14F became stuck in the BHA and after attempting to free it for over an hour the BHA had to be pulled to the surface to recover it. The drill string cleared the seafloor at 1725 h on 6 August. The top drive was set back, the drill string was pulled back to the rig floor, and the core barrel was removed from the BHA. Hole U1459A ended at 2135 h on 6 August.

In Hole U1459A, nine HLAPC piston cores penetrated 35.8 m and recovered 29.3 m of core. The five XCB cores penetrated 34.5 m and recovered 1.29 m. Overall core recovery for Hole U1459A was 30.59 m over a cored interval of 70.3 m (44%). The total time spent on Hole U1459A was 29.75 h.

After offsetting the vessel 20 m north, the APC/XCB BHA was reassembled and the bit lowered to just above the seafloor. A coring plan was prepared for Hole U1459B based on the recovery and penetration rates from Hole U1459A. Hole U1459B was spudded at 0025 h on 7 August. After drilling down 13.5 m, the center bit was pulled and an XCB core barrel was dropped. Core U1459B-2X was cut to 22.5 m (0.24 m recovered). The HLAPC system then recovered Cores U1459B-3F to 5F. The XCB system was again deployed at 34.8 m to core through another hard layer, and Core U1459B-6X recovered only 0.04 m of core. HLAPC Cores U1459B-11F to 46F then extended to 218.9 m where the HLAPC could not effectively penetrate any further. XCB coring continued to a final depth of 233.0 m (Cores U1459B-47X to 50X). After an hour of trying to advance Core 50X, the core barrel was pulled and wear on the XCB cutting shoe indicated that we had reached XCB refusal. The drill string cleared the seafloor at 1345 h on 8 August and Hole U1459B ended when the bit arrived back on the rig floor at 1640 h on 8 August. A total of 42 HLAPC piston cores were taken over a 189.7 m interval and recovered 170.93 m of core. Seven XCB cores were taken over an interval of 29.8 m and recovered 0.84 m. One 13.5 m interval was drilled without coring. Overall core recovery for Hole U1459B was 171.77 m over an interval of 219.5 m (78%). The total time spent on Hole U1459B was 43.25 h.

After offsetting the vessel 20 m north, an additional stand of drill collars was made up for the RCB BHA. The BHA was reassembled and the bit lowered to just above the seafloor. A drilling/coring plan was prepared for Hole U1459C based on the total depth of Hole U1459B and the APC/XCB recovery near the base of that hole. Hole U1459C was spudded at 2225 h on 8 August. At the end of the week, we were drilling ahead without coring at 7 m in Hole U1459C with the plan to continue drilling to ~200 mbsf and then begin RCB coring.

Science Results

Results from this week encapsulate Sites U1458 and U1459.

Site U1458

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. Cored material from U1458A suggests a hard seafloor comprising a ~10 cm thick lithified layer, with a soft, thin 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 were found, in diminishing order of abundance: rhodoliths, mollusk fragments, bryozoan, 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 sand suggests moderate-energy currents in the area.

Three core catchers were sampled for biostratigraphic analysis: U1458A-1H, 2H, and 4F. Core U1458A-3X did not yield any core catcher material. In addition to foraminifera and nannofossils, bryozoan, ostracods, and pteropods were found. One key planktonic foraminifera species (*Globorotalia tosaensis*) was identified, which provides an age at 3.12 mbsf of ~0.61 Ma. Calcareous nannofossils at the base of the site, specifically Gephyrocapsids and *G. caribbeanica*, indicate the estimated age at total depth (9.95 mbsf) is <1.73 Ma.

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.

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 property measurements 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 Cores U1458A-1H and 2H and 1.59 g/cm³ in 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 moisture and density (MAD) sample was taken in each of Cores 1H, 2H, and 4F; each had the same bulk density values as the GRA, and MAD grain densities did not vary. Cores 1H and 2H have higher porosity (~55%) than Core 4F (47%).

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

Site U1459

The sedimentology group described all of the recovered material from the first two holes of Site U1459. Hole U1459A was cored to 70.75 mbsf. The lithology is dominated by carbonate, and a preliminary lithostratigraphy suggests the hole consists of four units: Unit I (0–32.78 mbsf) is a lithified grain- to rudstone with a diverse assemblage of bioclastic components, including small and large benthic as well as planktic foraminifera; Unit II (32.78–42.7 mbsf) is a mudstone to

wackestone with cm-scale interlayers of skeletal grainstone; Unit III (42.7–66 mbsf) is unlithified to partially lithified pack- to grainstone with echinoderms and bivalves as the most dominant bioclasts; Unit IV (66–70.75 mbsf) is an unlithified homogeneous packstone with glauconite, and a high abundance of small benthic foraminifera.

Hole U1459B penetrated deeper than Hole U1459A, and extends to 233 mbsf. The lithostratigraphic units are also recognized in Hole U1459B: Unit I (0–22.5 mbsf), Unit II (22.5–31 mbsf), Unit III (40–102 mbsf), and Unit IV (102–179 mbsf). Unit IV in this hole is thicker (to 179 mbsf), which suggests that Hole U1459A does not contain the complete Unit IV package. A fifth unit (Unit V, 170–219 mbsf) has been identified in Hole U1459B and is a dolomitic packstone that transitions to a dolomitic grainstone interbedded with fine grained, well sorted quartz rich sand. Both interbeds contain macrofossils and hematite-stained particles.

The biostratigraphy team processed all core catcher samples from Hole U1459A (Cores 1F to 14F) and B (Cores 2X to 49X). Where the core catchers contained lithified material (i.e., Cores 49X and 50X), smaller pieces were soaked in water to retrieve a suspension of the finer material and produce nanofossil microscopy slides, but the core catchers were not analyzed for foraminifers.

Calcareous nanofossils are found within a micritic matrix with presence of μm -scale dolomitic rhombic crystals from Core U1259B-12F that increase in abundance further downhole. Neogene marker species indicate late Pleistocene ages in the upper part of the hole to late-middle Miocene ages in Core U1459B-48F.

Samples in the uppermost part of Site U1459A contained a higher species diversity (11–15 species) of planktic foraminifers in comparison to Site U1458 (5–6 species), whereas deeper in Hole U1459B (188–216 mbsf) the material is almost barren (98%–100%) with high occurrence of dolomitic encrustations on the tests. Preservation is generally moderate to low with a high incidence of dolomitic encrustation. The occurrence of marker species *Dentoglobigerina altispira* from Core U1459B-19F suggests an age of 3.46 Ma.

Samples in the uppermost part of the cored section contained higher species diversity (18–23 species) of benthic foraminifers, whereas deeper samples contain lower diversity (10–18). Preservation is generally low with high incidence of abrasion, fragmentation, and encrustation. There are some paleobathyal indicator species in Cores U1459A-1F and U1459B-20F, but due to poor preservation and the low abundance of these species, (paleo)depths are difficult to constrain.

Headspace gases were monitored in each core. Thus far, only very low concentrations of methane have been detected. Most samples have <2 ppm methane and undetectable ethane. Samples for interstitial water characteristics, including pH, alkalinity, salinity, and major and minor element content, were taken. In Hole U1459B, the pH of all samples measured is ~ 7.5 . Alkalinity ranges from 2.4–4.5 mM. Salinity at the top of Hole U1459B is 37 and increases with

depth reaching a value of 50 in Sections U1459B-3F-2 through 41F-2 (the deepest sample analyzed thus far). The squeeze cake and interstitial water samples are in various stages of preparation for other geochemical analyses including total organic and inorganic carbon content, total nitrogen, and major and minor element content.

Paleomagnetic studies focused on natural remanent magnetization (NRM) measurements of the archive-half sections and discrete samples from the working-half sections. The NRM was measured every 10 cm for archive-half sections using the cryogenic magnetometer. NRM was measured after stepwise alternating field (AF) demagnetization at 10 mT, 20 mT, as well as 30 mT when time allowed. When core flow increased, the sections were measured after AF demagnetization at 10 mT and 20 mT. AF demagnetization revealed the characteristic remanent magnetization (ChRM) of the sediments, which were then analyzed to determine the ages of apparent polarity reversals. Some chrons were tentatively identified (C2An.1n, C2An.1r, C2An.2r, C2An.3n, C2Ar, C3n.1n, C3m.2n, C3n.3n) in Cores 13F through 18F but require further investigation. Discrete samples were subjected to AF demagnetization at 10 mT, 30 mT, 50 mT, 70 mT, and 100 mT. If the magnetization was not lost during the standard demagnetization sequence, then additional demagnetization steps were added at intervals of 20 mT up to a peak field of 180 mT. One exceptional sample with high coercivity was subjected to isothermal remanent magnetization (IRM) acquisition measurements to identify the magnetic mineralogy composition. IRM was applied using the impulse magnetometer, in steps, with a peak field of 1200 mT. Its IRM acquisition behavior showed that the magnetic material is composed of some magnetite and a large portion of a mineral with higher coercivity, such as hematite or goethite.

Physical property measurements were collected for Holes U1459A and U1459B. Despite poor core recovery in Hole U1459A, the natural gamma ray (NGR) data from Hole U1459A shows distinct peaks in Cores U1459A-9F, 10F, 12F, and 13F that can be correlated with similar peaks in cores from Hole U1459B. Moreover, a tentative correlation with the NGR logging data from the adjacent Houtman-1 industry well was made. *P*-wave velocity measurements with the multi-sensor logger are no longer routinely taken because measured values were consistently out of the accepted range. Discrete sampling for moisture and density (MAD) were carried out at a rate of 1 to 3 samples per core, and measurements are in progress. During analysis of the first cores from Hole U1459A, the shear vane tool failed to operate properly and such measurements were subsequently not taken. Thermal conductivity measurements on the cores were only made down to Core U1459B-9F as successful in-situ formation temperature measurements with the APCT-3 could not be accomplished for this hole.

Stratigraphic correlation between the holes at this site was difficult; nevertheless, Hole U1459A was correlated with the upper ~71 m of Hole U1459B using coarse resolution (10 cm) magnetic susceptibility and gamma ray attenuation measured on whole-round core sections to monitor drilling progress. The correlations were refined using high resolution NGR and Color Reflectance (B*).

Education and Outreach

The onboard education/outreach team spent the first week scheduling outreach sessions, familiarizing themselves with the scientific aims and equipment of the expedition, meeting the science party and crew, and as well as increasing their knowledge about the expedition. They created eight blog posts and are engaging in Facebook (<https://www.facebook.com/joidesresolution>) and Twitter (<https://twitter.com/TheJR>).

Technical Support and HSE Activities

The first week involved the technical staff preparing for and implementing operations of the expedition.

Laboratories

- Prepared laboratories for coring operations, and supported processing of cores from Site U1458 and U1459.
- Scientists were introduced to their laboratory specialists and workflow.
- Incoming shipments and supplies were distributed and stored.
- Chemistry
 - Source rock analyzer (SRA) is fully functional and calibrated.
- X-ray diffraction
 - A new X-ray tube was installed.
- Superconducting Rock Magnetometer (SRM)
 - Communications problems between the SRM and the controlling computer were resolved.
- Logging Operations—Vertical Seismic Profile (VSP)
 - Seismic sources were rigged and prepared for downhole logging operations.
 - Protective Species Observer training was provided to new marine laboratory specialists.
 - A pre-VSP meeting was held which detailed the environmental restrictions for marine mammal, turtles, and diving birds.

Miscellaneous

- Facilitated laboratory tours for 191 general public and VIP guests on July 31.

Freight

- Offloaded:
 - One 40 ft flat with return platform and old subsea camera (VIT) cable.
 - One container with IODP miscellaneous content.

- Received:
 - IODP air shipment of O₂ sensor; installed on 3 August.
 - One IODP container of D-Tubes and miscellaneous science supplies.
 - One IODP Flat with 2 ea. core liners, sandline on metal pallet and miscellaneous supplies.

HSE Activities

- Safety tours were conducted for the science party on 1 August.
- Safety awareness sheets were completed for chemistry, physical properties, whole round multi-sensor track, and paleomagnetism areas.
- Safety showers and eyewash stations were tested on 6 August.
- A fire and boat drill was conducted on 4 August.