

## **IODP Expedition 382: Iceberg Alley and Subantarctic Ice and Ocean Dynamics**

### **Week 8 Report (5–11 May 2019)**

Week 8 of the International Ocean Discovery Program (IODP) Expedition 382, Iceberg Alley and Subantarctic Ice and Ocean Dynamics, was spent coring at Holes U1538A (64.8–676.0 mbsf; 412.6 m recovered, 68%), U1538B (seafloor to 8.5 mbsf; 8.5 m recovered, 100%), and U1538C (seafloor to 105.9 mbsf; 98.9 m recovered, 93%) at proposed Site SCO-11 in the Pirie Basin area. The bottom of Hole U1538A reached early Pliocene strata. During the week, drilling operations stopped for ~27 h because of icebergs and bad weather. All times in this report are in ship local time (UTC – 3 h).

### **Operations**

At the beginning of the week we were coring Hole U1538A at 64.8 mbsf. Over the next 5 d Cores U1538A-8H to 75X penetrated from 64.8 to 676.0 mbsf and recovered 412.6 m (68%). Formation temperature measurements were made while taking Cores 9H, 12H, 15H, and 18H. At 1130 h on 5 May, after taking Core 17H, an iceberg and a bergy bit entered the red zone, so we raised the drill string to 45 mbsf and offset 35 m to the northwest to allow the bergy bit to pass. At 1530 h the larger of the two icebergs was clear of the red zone and we lowered the drill string back to 159.8 mbsf and resumed coring. Because Core 30H was difficult to extract from the formation and required a drillover to retrieve it, we switched to half-length advanced piston coring (HLAPC) for Cores 31F to 34F, reaching 294.4 mbsf.

At that point the hole was deep enough that we would want to reenter it if forced off site by an iceberg, so at 1720 h on 6 May we deployed a free-fall funnel (FFF) to enable reentry. We resumed coring at 1830 h, taking Core 35F, which also required a drillover, so we switched to extended core barrel (XCB) coring for the rest of Hole U1538A. From 1300 to 1500 h on 8 May we waited for a large iceberg to pass the edge of the red zone (3 nmi from the ship), with the drill bit close to the bottom of the hole. Coring then continued until 2145 h, when another iceberg approached close to the red zone, but it changed direction away from the ship and we resumed coring at 2230 h. After taking Core 66X (597.9 mbsf), coring was interrupted from 0415 to 0900 h on 9 May when an iceberg passed through the red zone. We raised the drill string to 45 mbsf and waited until after the iceberg passed, with a closest distance of 1.2 nmi from the ship, before resuming coring. From 1930 to 2100 h ship heave was about 4 m, which was too high to maintain a consistent weight on bit, so we stood by and waited for heave to subside. The final cores of Hole U1538A, Cores 69X to 75X, were recovered without interruption. We stopped coring at 1315 h on 10 May after reaching the maximum depth of 676 mbsf permitted by the IODP Environmental Protection and Safety Panel for this site.

We decided to forego downhole logging of Hole U1538A because ship heave exceeded 3 m and was forecast to become higher, which would pose a risk to the downhole logging tools and increase uncertainty in the depth registration of the logging data. Because the hole has a FFF, it was possible that we could return to log it if sea and heave conditions became calmer before the end of operations at this site, so we displaced the hole with 10.5 ppg heavy mud to help stabilize the borehole walls.

We started Hole U1538B at 1900 h on 10 May. Core U1538B-1H recovered 7.8 m and was sampled for pore water at high resolution. We then offset 20 m to the south.

We started Hole U1538C at 2135 h on 10 May. Cores U1538C-1H to 12H penetrated from the seafloor to 105.9 mbsf and recovered 98.9 m (93%). One HLAPC core, Core 6F, was taken to adjust the depth offset to splice over core breaks in Hole U1538A. At 1000 h, the sea and wind conditions had deteriorated to the extent that we could not safely handle the core barrel on the rig floor. We waited with the drill string in the hole, but it was apparent that conditions would not improve, so at 1500 h we raised the drill string clear of the seafloor, ending Hole U1538C. The rest of the day was spent waiting on weather. At midnight, the ship's pitch, roll, and heave were 3.5°, 3.8°, and 6 m, respectively.

## **Science Results**

### *Lithostratigraphy*

Holes U1538A–U1538C were cored and described during Week 8. Lithostratigraphic Unit I, from the seafloor to 308 mbsf, consists of dark greenish gray, silty clay–rich and silty clay–bearing diatom ooze alternating with diatom-rich and diatom-bearing silty clay. Commonly the distinction between silty clay and diatom ooze was difficult to discern, because the terrigenous and biogenic components were each close to 50%. Some intervals of diatom ooze were over 20 m thick. Dropstones on the split core surface were small and rare, but more of them were evident in the X-ray images. In Sections U1538A-5H-2, 13H-2 to 7, and 14H-1 to 2, dispersed diagenetic carbonate occurred in layers >50 cm. In prior sites similar diagenetic carbonate was found as discrete mm to cm thick layers. Unit II is distinguished by increased compaction (lithified silty clay and diatomite) and a major increase in the abundance, size, and lithology of ice-rafted debris (IRD). Within Unit II distinct layers of enriched IRD were observed. Thin (<5 cm) diagenetic carbonate layers and lenses (bioturbation?) are present in Sections U1538A-40X-5 and 56X-5.

### *Biostratigraphy*

Analyses of microfossils, including diatoms, radiolarians, and palynomorphs, were conducted on samples from Hole U1538A. Diatoms and radiolarians were found in all core catcher samples (from 1H-CC through 75X-CC) and additional samples collected from selected depths. The

deepest sample revealed that sediments recovered at this site date back to ~4.2–4.7 Ma. Limited reworking of diatoms was detected. Although fragmentation exceeded dissolution, overall preservation was relatively good in all samples. Samples for the analysis of ancient DNA were also collected from Cores U1538C-1H through 8H and 10H, and are anticipated to record the Holocene and Termination II. Palynomorphs (dinocyst, acritarch, prasinopytes, pollen, spores, copepod, and fungi remains) were identified in all 30 samples processed for palynology. Dinocyst diversity was generally low with varying abundance throughout. Reworked pollen and spores were found throughout, while in situ specimens were only detected in certain intervals.

### *Paleomagnetism*

Paleomagnetic investigations at Site U1538 involved measurement of the natural remanent magnetization (NRM) of archive halves from all holes before and after demagnetization in a peak alternating field (AF) of 15 mT. All discrete samples from Site U1538 have been subjected to AF demagnetization at 5, 10, and 15 mT to verify the archive-half measurements. Directional data agree well between archive-half and discrete samples in APC and HLAPC cores. XCB cores often had a large amount of scatter in archive-half measurements, making those data difficult to interpret. However, discrete samples taken from large, intact pieces in the XCB cores appear to reliably record polarity and can be used for magnetic stratigraphy. We have identified polarity zones from C1n (Brunhes Chron) to C3n (middle Gilbert Chron); however, not all polarity zones of the GTS12 timescale were identified, including subchrons of C2An (Gauss Chron) and C3n (middle Gilbert Chron). This is probably a result of discontinuous recovery. The paleomagnetists are currently working with the biostratigraphy and stratigraphic correlation teams to build an age model for the site.

### *Geochemistry*

We collected and analyzed 69 samples from Hole U1538A for headspace gas analyses. At Hole U1538A methane is the dominant hydrocarbon and is present only in low concentrations (2.0–5.4 ppmv). Ethane (C<sub>2</sub>H<sub>6</sub>) concentration is below the detection limit. A total of 111 samples were collected for solid phase analyses from Hole U1538A and the analyses carried out consisted of measurements of inorganic carbon, total nitrogen (TN), and total carbon (TC). So far, 79 samples have been analyzed, showing relatively low TOC (0.2–0.75 wt%), TN (0.04–0.23 wt%), and CaCO<sub>3</sub> (0.02–4.2 wt%) contents.

Pore water geochemical data were generated on 40 samples from Hole U1538A (Cores 1H through 75X) to a depth of 670.75 mbsf. The inorganic geochemical data of Site U1538 fall at the more extreme end of pore water properties observed during Expedition 382. While the core is not methanogenic, sulfate is depleted below 60 mbsf. Minor dissolved sulfate concentrations were detected below 500 mbsf (SO<sub>4</sub> < 1.5 μM). Significant organic matter degradation is apparent in the upper 120 m with elevated phosphate concentrations and a pronounced Br/Cl gradient. Barite dissolution is evident at depths without resolvable sulfate between 60 and 445 mbsf, displaying the highest dissolved barium concentrations seen at any of the Expedition

382 sites. The spatial evolution of the Ba enrichment differs from the previous sites in that Ba concentrations increase over more than 300 m with depth before decreasing again within a few tens of meters. Dissolved Mn enrichment is observable in the uppermost 50 m at Site U1538, followed by Fe enrichment below, suggesting Mn-Fe oxide mobilization in the upper 260 m. Calcium concentrations decrease significantly from 11.7 to 1.9 mM within the sulfate reduction zone, recover to stable intermediate concentrations throughout the upper half of Site U1538, and become enriched deeper. Together with equally increasing B and Sr concentrations this suggests increasing exchange reactions between the dissolved and solid phases in the older sediments. While chloride concentrations decrease with depth together with pore water salinity, sodium concentrations increase. Authigenic clay formation is apparent in decreasing potassium and magnesium concentrations in deeper parts of Site U1538. In comparison to the pore water profiles from Scotia Sea Sites U1536 and U1537, these data highlight the more exotic character of the profiles from Site U1538.

### *Petrophysics*

The Whole-Round Multisensor Logger (WRMSL) was used to measure density, magnetic susceptibility (MS), and *P*-wave velocity at 1 cm intervals—a higher spatial resolution than the previous sites, where we used 2.5 cm spacing. Natural gamma radiation (NGR) was measured on the whole-round sections for sections larger than 50 cm. The core section halves were scanned on the X-ray imager. Discrete measurements collected in section halves include *P*-wave velocity (at least three per full APC core) and 150 thermal conductivity measurements (2–3 per core). Moisture and density measurements were made on 145 discrete samples from Hole U1538A. Light reflectance and MS point measurements were collected at 1 cm intervals in section halves from Cores U1538A-1H to 35F, and at 2 cm in the remaining cores of this site. Five formation temperature measurements (Cores U1538A-6H, 9H, 12H, 15H, and 18H) taken with the advanced piston corer temperature (APCT-3) tool yielded temperatures of 4.85°–13.8°C.

In the upper 220 m, physical property records have 10–20 m long amplitude cycles (e.g., bulk density values cycling from lows of 1.2 g/cm<sup>3</sup> to highs of 1.7 g/cm<sup>3</sup>, and NGR values from lows of 10 counts/s to highs of 40 counts/s). Below that depth, the cycles have a shorter scale, have slightly lower amplitude, and are superimposed on longer scale baseline changes. An exception is the high amplitude MS cycles from 310 to 450 mbsf, underlain by low baseline MS values from 450 to 550 mbsf. The overall cycles and patterns are comparable in amplitude and thickness to those seen at Sites U1536 and U1537 in Dove Basin to the southwest. Downhole sediment compaction is reflected in increased density and *P*-wave velocity with depth. An increase in baseline values of NGR, density, and *P*-wave velocity is associated with a change in seismic facies at ~370 mbsf. Due to ship heave, the overlap between cores in Holes U1538A and U1538C is not ideal and there is distortion of the lithologic thicknesses that makes it challenging to correlate and make a complete stratigraphic splice.

## **Outreach**

[joidesresolution.org](http://joidesresolution.org): We posted four blogs this week, including an interview with Co-Chief Scientist Mike Weber, a visit from a radiolarian specialist, and “What’s on the Table.”

*Twitter* (<https://twitter.com/TheJR>): We posted 11 tweets this week, including the paleomagnetic cube sample photo, a Mother’s Day photo, and a link to Suzanne O’Connell’s piece in the online science magazine, *The Conversation*.

*Instagram* ([http://instagram.com/joides\\_resolution](http://instagram.com/joides_resolution)): There were eight posts this week, including a pyritized foraminifer photo (122 likes) and reentry cone photos (121 likes).

*Live Events*: with scientist Q&A (Total students reached: ~390)

- University of the Philippines— with Ivan, Thomas, Stefanie, Anna, Frida, Yuji
- Lycée Vincensini— Thomas, Michelle, Ivan, Frida, Stefanie
- Chico Junior High School— Suzanne, Vicky
- Centro Solesano— Ivan, Lara, Thomas, Michelle, Frida
- Unisinos University— Thomas, Ivan, Yuji, Anna, Frida, Stefanie
- Cerritos College— Marga, Jonathan, Linda
- IES Prof. Pablo— Ivan, Thomas, Michelle, Frida
- Geological Sciences— Yasmina, Mike, Marga, Suzanne, Brendan, Jonathan
- Hamilton School— Yasmina, Brendan, Shubham, Linda
- Claymont Elementary— Suzanne, Jonathan, Linda
- Chinese school— Xufeng Zheng, Yasmina, Suzanne, Brendan, Lee

*Other Outreach Items*:

- Shipboard workshop about Twitter for scientists

## **Technical Support and HSE Activities**

*Laboratory Activities*

- Technicians continue to heat the core liners with heat guns on the catwalk to prevent liners from cracking.
- The Cryomech compressor on the superconducting rock magnetometer (SRM) gave a high oil temperature alarm on Tuesday, prompting the technicians to switch to the Haskris water chiller for chill water delivery. The scientists evaluated the SRM field and decided to continue measuring. The Siem Offshore Engineering Department did not find any problem with the ship’s chill water system but they were able to slightly increase the flow rate so that the compressor could be switched back to ship’s chill water.

- The sinks in the Paleontology Preparation Laboratory are draining efficiently. The Siemens Offshore Engineering Department cleared a blockage in the drain line under the catwalk.
- The Bruker D4 X-ray Diffractometer was down temporarily when a limit switch was inadvertently hit while maintenance was being performed. The internal mechanical sample lift, which was making noise, was found to have corrosion and was cleaned. The instrument is operational.

#### *HSE Activities*

- We conducted the weekly fire and abandon ship drill.
- Safety showers and eyewash stations were tested.