

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

Week 7 Report (28 April–5 May 2019)

Week 7 of the International Ocean Discovery Program (IODP) Expedition 382, Iceberg Alley and Subantarctic Ice and Ocean Dynamics, was spent coring at Sites U1537 (proposed Site SCO-18A) and U1538 (proposed Site SCO-11): Holes U1537A (154.5–264.0 mbsf; 108.8 m recovered, 99%), U1537B (seafloor to 7.4 mbsf; 7.4 m recovered, 100%), U1537C (seafloor to 15.3 mbsf; 11.9 m recovered, 78%), U1537D (seafloor to 354.3 mbsf; 349.0 m recovered, 99%), and U1538A (seafloor to 64.8 mbsf; 63.8 m recovered, 98%). Hole U1537D reached early Pliocene strata, and we ended operations there to leave sufficient time for coring and logging at Site U1538 in the Pirie Basin area. During the week, drilling operations stopped for ~18 h because of icebergs. All times in this report are in ship local time (UTC – 3 h).

Operations

At the beginning of the week we were coring Hole U1537A at 154.5 mbsf. Cores U1537A-18H to 31F penetrated from 154.5 to 264.0 mbsf and recovered 108.8 m (99%). After Core 26H was difficult to pull out of the formation and had to be drilled over, we switched to half-length APC (HLAPC) coring at 240 mbsf. An iceberg moved into the red zone at 1830 h on 28 April, so we raised the drill string to 38 mbsf; at 2020 h, after further encroachment of the iceberg, we ended Hole U1537A.

Although we could not core at depth in Hole U1537A, we could take a mudline core because this operation does not require the drill string to be below the seafloor, and the iceberg was not close enough to be within the termination zone. Hole U1537B started at 0010 h on 29 April and consisted of a single core taken for high-resolution pore water sampling. Core 1H penetrated from the seafloor to 7.4 mbsf.

Hole U1537C started at 0135 h on 29 April and Cores U1537C-1H to 2H penetrated from the seafloor to 15.3 mbsf, recovering 11.9 m (78%). After the Core 2H liner shattered and two large icebergs entered the red zone at 0400 h, we decided to end Hole U1537C at that point. We raised the drill string clear of the seafloor and moved aside in dynamic positioning mode to let the icebergs pass. By 1500 h we were able to move back to the site location.

Hole U1537D started at 1945 h on 29 April. Cores U1537D-1H to 50F penetrated from the seafloor to 354.3 mbsf, recovering 349.0 m (99%). We took two HLAPC cores (Cores 20F and 21F) across a hard layer that had been found in Hole U1537A at ~182 mbsf, before returning to full length APC coring for Cores 22H to 27H. Below 244 mbsf the formation was too hard for APC coring, so we used HLAPC coring from that point down to the bottom of the hole. Some of the core liners cracked along their length when the first cut was made to divide the cores into

1.5 m sections. To alleviate this problem, we warmed up the core liners around the section boundaries to make them less brittle before cutting them. Icebergs were monitored on 30 April and 1 May, but none of them posed a hazard to operations. On 2 May, about eight icebergs were visible on the horizon all day. From 1345 to 1430 h we waited to monitor an iceberg that was at the edge of the red zone, but it turned away from the ship and we could resume coring. Because high winds and swell were forecast for 3 May, we decided to end Hole U1537D in the early evening of May 2 to leave enough time to raise the drill string to the ship and also to leave sufficient time for the coring and logging program at the next site (proposed Site SCO-11) in the Pirie Basin area. The bit cleared the seafloor at 2140 h, and after some rig floor maintenance was completed, the drill string was raised to the ship by 1030 h on 3 May, which completed operations at Hole U1537D.

At 1130 h we started the 127 nmi transit to Site U1538 (proposed Site SCO-11A). The transit took 15 h at an average speed of 8.4 kt. On arrival at the site we lowered the thrusters, assembled the drill string, and lowered it to the seafloor. We started Hole U1538A at 1615 h on 4 May. The seafloor depth was 3130.6 m below sea level as calculated from the mudline. Cores U1538A-1H to 7H penetrated from the seafloor to 64.8 mbsf and recovered 63.8 m (98%). A formation temperature measurement was made while taking Core 6H. At the end of the week we were coring Hole U1538A.

Science Results

Lithostratigraphy

Cores from Holes U1537A to U1537D were described visually and imaged with the X-ray scanner. Three major lithologic units were identified. Unit I (0–180 mbsf) consists of interbedded diatom ooze and silty clay. Although the unit is dominated by diatom ooze it is subdivided into three subunits, depending upon the relative abundance of diatom ooze and silty clay. Unit II (~180–260 mbsf) is almost exclusively silty clay with varying amounts of biosilica and contains discrete color-banded intervals. Unit III (260–354 mbsf) is more lithified and consists of interbedded silty clay and diatom ooze. Unit III contains a series of slumps with inclined and folded beds, interbedded with horizontally layered sediment. Throughout, ice-rafted debris was rare to common and was particularly visible in the X-ray images as granule to pebble-sized dense shadows. Bioturbation was also rare to common with extensive thin (millimeter-thick) pyritized burrows visible in the X-ray images.

Biostratigraphy

Diatoms and radiolarians were found in all core catcher samples and samples collected from selected depths in between. The lowermost sample (U1537D-50F-CC) revealed that the oldest sediments recovered at this site are early/mid-Pliocene (~4.45–5.0 Ma). No major hiatuses were

detected. There was considerable reworking of diatoms and radiolarians, especially in Samples U1537D-37F-1, 75 cm, through 41F-2, 75 cm. Overall preservation was relatively good in all samples, and fragmentation was more common than dissolution.

Palynomorphs (dinocyst, acritarch, prasinopytes, pollen, spores, copepod, and fungi remains) were identified within the 23 samples processed for palynology. Dinocyst diversity was generally low, with relative abundance varying from abundant/common in the upper 155 mbsf to few/barren in the lower half of Holes U1537A and U1537D, with the exception of Samples U1537D-38F-CC through 42F-CC, which had a relatively high dinocyst abundance.

Paleomagnetism

Paleomagnetic investigations focused on completing the natural remanent magnetization (NRM) measurements and alternating field (AF) demagnetizations of archive-half and discrete samples from Holes U1537A and U1537D. All discrete samples from Site U1537 have been subjected to AF demagnetization at 5, 10, and 15 mT to verify the archive-half measurements. Directional data match well between archive-half measurements and cube samples, with the notable exception of cores affected by broken liners. In these sections, careful selection of cube sample locations to target intact, undisturbed sections of core helped us to interpret ambiguous results in the archive-half measurements. The combined paleomagnetic records from Holes U1537A and U1537D recovered a complete record spanning Chrons C1n (Brunhes) to the base of C2An.2r (Mammoth; 3.33 Ma). Deeper than C2An.2r we measured approximately 5 m of normal polarity, which we interpret as C2An.3n (Early Gauss). This interpretation places the base of this polarity zone between 3.33 and 3.60 Ma on the GTS2012 timescale. Intervals of slumped sediments underlie this normal polarity zone, but the intervening flat-lying sediments include a polarity transition and about 20 m of reverse directions, which we interpret to be the base of C2An and C2Ar (late Gilbert). The two lowermost cores of Hole U1537D, 49F and 50F, have scattered paleomagnetic directions and cannot be assigned to a polarity zone at this time, suggesting that the base age for Hole U1537D above these two cores is between 3.6 and 4.2 Ma.

Geochemistry

A total of 39 samples from Holes U1537A and U1537D were collected and analyzed for headspace gas. Downhole profiles of headspace gas and bulk inorganic and organic carbon in Site U1537 are very similar to those from Site U1536. Methane concentrations in headspace gas were low (<3.5 ppmv) in all cores, and concentrations of ethane and propane were below the detection limit throughout the hole. Hole U1537A had relatively low contents of total organic carbon (0.02–0.81 wt%), total nitrogen (0.057–0.087 wt%), and calcium carbonate (0.23–0.96 wt%). Pore water geochemical data were generated on 20 samples from Cores U1537A-1H to 31F and three samples between Cores U1537D-38F and 50F, to a depth of 352 mbsf. Furthermore, a total of 27 sediment samples were taken for bulk sediment analyses from Hole U1537A, and eight samples from deeper horizons of Hole 1537D were chosen and prepared for future bulk sediment geochemical analyses later in the expedition.

Site U1537 has comparable trends to Site U1536 but with some subtle differences. The sulfate-depleted zone is significantly less expanded than at Site U1536, encompassing less than 80 m. Dissolved Ba contents at those depths are significantly lower than at Site U1536, and alkalinities reach less than 30 mM (compared with almost 40 mM at Site U1536). Ammonia concentrations are also lower. Systematic Mg and K depletion downhole suggests that continuous authigenic clay formation occurs throughout the sediments. Calcium is precipitated from pore water in the upper section and replenished below the sulfate reduction zone. Other major and trace elements, such as B, Si and Sr, increase downhole. Fe contents are generally low, whereas Mn is somewhat elevated in the uppermost 30 m. Overall the observed geochemical patterns suggest only moderate diagenesis, which is encouraging for a variety of planned postexpedition geochemical analyses. Samples were collected for headspace gas and interstitial water chemistry analyses in Hole U1538A.

Petrophysics

The Whole-Round Multisensor Logger (WRMSL) was used to measure bulk density, magnetic susceptibility (MS), and *P*-wave velocity at 2.5 cm intervals. Natural gamma radiation (NGR) was measured on whole-round sections longer than 50 cm. Discrete measurements collected from section halves include *P*-wave velocity (at least three per full APC core) and thermal conductivity (one per core). A total of 59 thermal conductivity measurements were conducted. Moisture and density measurements were made on 117 discrete samples. Light reflectance and MS point measurements at 2.5 cm intervals as well as digital and X-ray images were taken for section halves. One formation temperature measurement was taken with the advanced piston corer temperature tool (APCT-3) on Core U1537D-5H, yielding a temperature of 3.93°C.

Distinct cyclic changes were observed in physical property records in Holes U1537A and U1537D, especially in the NGR and MS values. In the upper 180 m, there are 10 m long cycles with large amplitudes (e.g., bulk density from lows of 1.25 g/cm³ to highs of 1.7 g/cm³, and NGR from lows of 10 to highs of 40 counts/s). Below that depth, the cycles are shorter scale, have lower amplitude, and are superimposed on longer scale baseline changes. The cyclic changes are likely controlled by insolation-driven climate variations, and are useful for stratigraphic correlation. Downhole sediment compaction is reflected in the overall increasing trend in density and *P*-wave velocity with depth. Step changes in the physical property records line up with main discontinuities in the seismic and echo sounder profiles. In particular, a baseline increase in bulk density, MS, and NGR at ~180 mbsf is associated with Reflector b in the preexpedition seismic interpretation. Additionally, an increase in velocity and density observed at 230 mbsf is coincident with an increase in reflectivity in the seismic data.

Outreach

joidesresolution.org: We posted eight blogs this week including answers to reader questions, geochemistry, and three about the utility and elaborate forms of radiolarians and other microfossils.

Twitter (<https://twitter.com/TheJR>): We posted 10 tweets this week, including icebergs of Iceberg Alley, announcements about blog posts, the radiolarian photo gallery (28 RTs, 88 likes), and 5 Things You Didn't Know About Icebergs (34 RTs, 63 likes, 1721 views).

Facebook (<https://www.facebook.com/joidesresolution>): Facebook posts included:

- Signs of Life Where You Least Expect It (5.4K people reached, 117 clicks/actions),
- 5 Things You Didn't Know About Icebergs (video) (12.7K people reached, 459 clicks/actions, 1657 views),
- and a Facebook Live interview with Staff Scientist Trevor Williams.

Instagram (http://instagram.com/joides_resolution): There were seven posts this week, including the radiolarian photo gallery (177 likes) and penguins on an iceberg (87 likes).

Live Events: with scientist Q&A (Total students reached: ~220)

- Colegio Andres de Vandelvira— with Yasmina Martos, Ivan Hernandez-Almeida, Michelle Guitard
- Western Springs College— with Suzanne O'Connell
- Texas State Aquarium— with Brendan Reilly, Vicky Peck
- IE Servero Ochoa— with Yasmina Martos, Michelle Guitard, Ivan Hernandez-Almeida, Stefanie Brachfeld
- New Brunswick Public Library— with Vicky Peck
- Buffalo State University— with Suzanne O'Connell, Brendan Reilly, Jonathan Warnock
- IES Virgen del Carmen— with Yasmina Martos

Other Outreach Items:

- YouTube: 5 Things You Didn't Know About Icebergs animation
- March For Science
- Two Science Communication Workshops for expedition scientists
- Friends and family broadcasts for scientists

Technical Support and HSE Activities

Laboratory Activities

- Core liners were cracking and shattering on the catwalk when cutting them, possibly because of the cold temperatures. Technicians are heating the liners with heat guns around section breaks to make them less brittle, successfully preventing cracking.
- The 3D Printer has been set up and testing is in progress.
- The sinks in the Paleomagnetism Laboratory are not draining efficiently. The Siem Offshore Engineering Department is looking for a blockage in the drain lines. Core catcher sieving has been moved to the splitting room.

Application Support Activities

- Improvements were made to the X-Ray Image Processor software, fixing several bugs, including overlaying sample information and a scale bar onto processed images, and automatically placing processed images into a unique folder.
- ImageCapture: we worked with a paleontology scientist to try to correct the problem with the scale bar on photomicrographs; the scale bar always appears at millimeter scale, but they would like to be able to change the scale to micrometers instead. This request has been placed in pending status for further analysis.

HSE Activities

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