

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

Week 5 Report (14–20 April 2019)

Week 5 of the International Ocean Discovery Program (IODP) Expedition 382, Iceberg Alley and Subantarctic Ice and Ocean Dynamics, was spent coring and drilling without recovery at Holes U1536C (16.1–352.0 m below seafloor [mbsf]); 187.4 m recovered, 90% of the cored interval), U1536D (0–6.9 mbsf; 6.9 m recovered, 100%), and U1534E (0–559.0 mbsf; 74.2 m recovered, 34% of the cored interval). These holes aimed to document variations in iceberg activity, sea ice cover, sea surface temperature, and water mass properties in the south Scotia Sea from the late Miocene to the Holocene. During the week, drilling operations stopped for ~32 h because of icebergs and bad weather conditions. All times in this report are in ship local time (UTC – 3 h).

Operations

At the beginning of the week we had started operations in Hole U1536C, reaching 16.1 mbsf in a water depth of 3222 mbsl. The aim of Hole U1536C was to spot core the upper section in order to fill gaps in the stratigraphy recovered from Holes U1536A and U1536B, and then to core continuously deeper than 224 mbsf. Cores 4H to 17F (and the drilled intervals 31, 91, 111, 131, 161, and 271, which advanced 144.0 m without recovery) penetrated from 16.1 to 352.0 mbsf and recovered 187.4 m (90% of the cored interval). We encountered hard layers at 225 and 292 mbsf, which were thought to be cemented tephra layers. At 2245 h on 15 April an iceberg entered the “red zone,” when the projected Closest Point of Approach (CPA) of an iceberg is less than 3 nmi and the time for it to reach the CPA is less than twice the time required to pull up the drill string to within 50 m below the seafloor. We stopped coring at that point and raised the drill string from 341.4 to 50 mbsf. By 0700 h on 16 April, the iceberg had passed our location and we started to lower the drill string to resume coring. We were able to advance to 352.0 mbsf, but at 1400 h another iceberg entered the red zone, and we decided to end Hole U1536C, pull the drill string out of the hole, move 20 m north, and take a further mudline core for high-resolution pore water sampling. Because the drill pipe was above the seafloor, mudline coring and pipe tripping operations could be performed safely, despite the presence of icebergs in the area.

Hole U1536D started at 1940 h on 16 April. Core 1H penetrated from the seafloor to 6.9 mbsf. However, the core liner shattered and the core had to be pumped out of the barrel, so it could not be used for the purpose of pore water sampling. We ended Hole U1536D and raised the drill string up to the ship to change over to the rotary core barrel (RCB) bottom-hole assembly.

Hole U1536E started at 2140 h on 17 April. We drilled without recovery to 312 mbsf, and at 0850 h on 18 April we deployed a free-fall funnel, which would enable reentry into the hole if

icebergs forced us to pull out and move aside. We then continued to drill down to 340 mbsf, just shallower than the depth reached by Holes U1536A and U1536C. At 1300 h, before we could start coring, an iceberg entered the red zone, so we pulled the drill string up to ~50 mbsf and waited for the iceberg to pass. At 1700 h we resumed operations and lowered the drill string back down the hole. The bottom of the hole contained 3 m of soft fill. From 2000 h until the end of the week, Cores 2R to 24R penetrated from 340.0 to 559.0 mbsf and recovered 74.2 m (34%). Coring was interrupted three times. The first interruption was from 0315 to 0700 h on 19 April when an iceberg entered the red zone, and we raised the drill string to 50 mbsf and waited for it to pass. The second was from 2130 to 2315 h on 19 April, when weather conditions deteriorated and heave reached up to 5.8 m, requiring us to raise the drill string a few meters off the bottom of the hole. The third interruption started at 1400 h on 20 April, when an iceberg entered the red zone, and we raised the drill string to 50 mbsf. After that iceberg moved past our location, there was no time to resume coring because a second iceberg was approaching and entered the red zone at 2200 h. At the end of the week we were on standby mode.

Science Results

Lithostratigraphy

Lithostratigraphic work during the week focused on sediment description and analysis of Holes U1536C, U1536D, and U1536E. The only core from Hole U1536D is composed of unconsolidated dark greenish gray diatom ooze at the mudline. Cores U1536C-1H to 19H (0–245 mbsf) repeat the dominant diatom ooze stratigraphy seen at Holes U1536A and U1536B. Planktonic foraminifers (*Neogloboquadrina pachyderma* sinistral) are rare within the ooze, but it is notable that these calcareous microfossils are present at all at this depth in the Southern Ocean. Cores U1536C-20H to 40F (245–359 mbsf) are dominantly composed of diatom-bearing to diatom-rich silty clay. RCB cores from Hole U1536E have a lower recovery and a higher degree of drilling disturbance than the piston cores from the other holes at this site. Cores U1536E-2R to 24R (340–559 mbsf) are composed of dark greenish gray diatom-bearing silty clays interbedded with coarser sandy silts and rare gravel layers. Ice-rafted debris (IRD) tends to be more common in these cores and contains larger dropstones with higher diversity in lithology and size than in the overlying units.

Biostratigraphy

Siliceous microfossils: Core catcher samples from Hole U1536E were analyzed for diatoms and date the stratigraphy from the late Pliocene (Sample U1536E-2R-CC; 347 mbsf) to the late Miocene (Sample U1536E-22R-CC; 534 mbsf). Diatom preservation and abundance generally declined downhole, and Samples U1536E-17R-CC, 23R-CC, and 24R-CC were barren. Radiolarians were common to abundant, and relatively well preserved until Sample U1536E-17R-CC. Below that sample, the preservation was poor and only trace amounts of radiolarians

were observed in Samples U1536E-22R-CC to 24R-CC. The ages range from late to early Pliocene down to Sample U1536E-9R-CC, and early Pliocene to late Miocene in the underlying samples. Samples for the study of ancient DNA (1–2 per core) were collected from Cores U1536C-1H through 12H as well as 20H, covering glacial–interglacial transitions.

Palynomorphs (dinocyst, acritarch, prasinopytes, pollen, spores, copepod, and fungi remains): Samples U1536C-38F-CC and 40F-CC were analyzed and Samples U1536E-2R-CC to 24R-CC were processed. Full analysis is ongoing, but the preliminary results show low numbers and poor preservation of most palynomorph groups in these intervals. Reworked spores are the most common feature. One age constraint from Sample U1536E-16R-CC corroborates the early Pliocene to late Miocene age estimate.

Biostratigraphic models from the different microfossil groups agree with each other and show that Hole U1536E records a continuous or near-continuous late Miocene to late Pliocene record. The transition from Miocene to Pliocene sediments is preliminarily placed at ~450 mbsf. Sedimentation rates are relatively low compared to the Pleistocene.

Paleomagnetism

Paleomagnetic investigations focused on measuring the natural remanent magnetization (NRM) of archive-half sections and discrete samples from Holes U1536B, U1536C, and U1536E. Sections were demagnetized at 10 and 15 mT peak alternating field (AF) demagnetization steps, with the drill string overprint generally removed by the 10 mT step. Selected discrete samples were subjected to stepwise AF demagnetization, and all samples from Hole U1536E were subjected to 5, 10, and 15 mT AF demagnetization to verify the archive-half measurements. All polarity zones of the 2012 Geologic Timescale have been identified in the advanced piston corer (APC)-cored intervals of Site U1536 through the lower Gauss (C1n–C2An.3n; 3.6 Ma), and polarity transitions were recovered for all polarity zone boundaries except one. Accordingly, there is a robust magnetostratigraphic age model for APC-cored intervals of Site U1536. Discrete subsamples from Hole U1536A were used to further explore the carriers of the NRM via the AF demagnetization behavior of natural and laboratory-induced remanence. Initial results suggest that the carrier of the remanence is primarily (titano)magnetite. Discrete subsamples were also analyzed using anisotropy of magnetic susceptibility. Ongoing investigation of the RCB-cored portion of Hole U1536E using both archive-half and discrete sample measurements has identified intervals of normal and reverse polarity, likely including Chrons C2Ar to C3An.

Geochemistry

Only a few samples were processed this week because most time was spent coring previously cored intervals. Twenty-seven headspace gas analyses were made on the lowermost cores of Hole U1536C and all cores of Hole U1536E. Very low concentrations of methane (<2 ppmv) were found in all cores from Hole U1536E. Seven pore water samples were taken and aliquots were prepared for ongoing geochemical analyses. Sediment samples were prepared for ICP-AES

(inductively coupled plasma–atomic emission spectroscopy) geochemical measurements, to be run after the finalization of the pore water analyses. Eighteen samples from Hole U1536E were powdered and weighed for carbonate analyses.

Petrophysics

The Whole-Round Multisensor Logger (WRMSL) was used to measure density and magnetic susceptibility (MS) at 2.5 cm resolution. WRMSL *P*-wave velocity measurements were not possible as RCB cores do not completely fill the liner. Natural gamma radiation (NGR) was also measured on whole-round cores. Discrete measurements included *P*-wave velocity (one per section), 17 thermal conductivity measurements, 28 moisture and density measurements, as well as X-ray imaging. Cyclic changes in NGR are observed throughout the hole, and the highest values occur from 470 to 490 mbsf. Downhole sediment compaction is reflected in increased density and *P*-wave velocity with depth. MS also increases gradually with depth. Changes in the character of the density and *P*-wave velocity records agree with main reflectors observed in multichannel seismic profiles in this location. In particular, a steep increase in density and velocity at 455 mbsf is associated with the top of a higher amplitude series of reflections in the seismic profile. Additionally, density measurements have an abrupt trend change after encountering a reflector at around 375 mbsf.

Outreach

We conducted video shoots with Co-Chief Scientist Mo Raymo for the CBS This Morning show, including coordination with IODP JRSO and the CBS producer. The segment will air on Earth Day, Monday 22 April 2019.

joidesresolution.org: We posted two blogs this week, one about ice-rafted debris, and one about smear slides.

Twitter (<https://twitter.com/TheJR>): We posted eight original tweets, including links pointing to the blog posts. The top tweet of the week was about icebergs on the radar (10 retweets, 29 likes). Expedition scientists have also been posting on Twitter.

Facebook (<https://www.facebook.com/joidesresolution>): We uploaded seven posts, including posts linking to the blogs and the iceberg word of the day.

Instagram (http://instagram.com/joides_resolution): We uploaded four posts and two Instagram stories, including about the sedimentology group (70 likes) and an IRD collage.

Live Events: We conducted six video conferences with schools and universities, and a Facebook Live Q&A with Co-Chief Scientist Mike Weber.

Technical Support and HSE Activities

Laboratory Activities

- The laser on the Section Half Multisensor Logger (SHMSL) developed problems. First it started intermittently measuring the length of sections incorrectly, and the length had to be entered manually by the user. Then the laser would not measure the height of the core surface correctly, so the instruments would not set down on the core material. The SHMSL eventually froze up completely, so the AR700 laser and power supply were replaced and all laser connections and settings were checked. The system is working again but users are watching it closely.
- On the Whole-Round Multisensor Logger (WRMSL), a negative drift was noticed in the water density values over time. The detector was reset and recalibrated but drift was still observed. The gamma ray standard and water pusher sections were remade from new core liners. The position of the gamma ray source was also adjusted and fixed in place. The density values measured on the standards are within range and will be monitored.
- After the inline processing of X-ray images with the Integrated Measurement System (IMS) software, dark and often black images were observed for APC core sections. The raw images were reprocessed by the science party. The cause of the dark images was identified and the processing settings will be adjusted for future APC imaging.
- On the NGR instrument, technicians adjusted the settings on Detector 7 to bring its calibration values in line with the other seven detectors' calibrations. The K-40 peak of Detector 7 is still drifting towards higher apparent energy. Troubleshooting will continue.
- Troubleshooting continued on the superconducting rock magnetometer IMS software to find all instances where it writes the INI file, so we can stop the application from writing a new INI file each time it opens.

IT Support Activities

- We completed migration of Asset Management System (AMS) services from the old Windows 2008 server to the new Windows 2016 server.

HSE Activities

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