

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

### **Week 3 Report (31 March–6 April 2019)**

The first half of Week 3 of the International Ocean Discovery Program (IODP) Expedition 382, Iceberg Alley and Subantarctic Ice and Ocean Dynamics, was spent coring in Holes U1534A (141.9–266.3 m below seafloor [mbsf], 124.9 m recovered, 100%), U1534B (0–1.5 mbsf, 1.5 m recovered), U1534C (0–168.0 mbsf, 159.6 m recovered, 95%), U1534D (0–28.5 mbsf, 29.6 m recovered, 104%), and U1535A (0–117.3 mbsf, 112.4 m recovered, 96%) to document Pliocene–Pleistocene variations in the Subantarctic Front. The second half of the week was spent in transit to the Scotia Sea, and preparing to core Site U1536 (proposed Site SCO-13A). All times in this report are in ship local time (UTC – 3 h).

### **Operations**

Week 3 of the expedition began on 31 March 2019 at Site U1534 (proposed Site SFSD-03A) with Core U1534A-21F at 141.9 mbsf. Half-length advanced piston coring (HLAPC) continued until we encountered a hard layer at 255.5 mbsf, so we switched to extended core barrel (XCB) coring to pass below the layer and took Cores 46X and 47X, which completed coring in this hole. Cores 21F to 47X penetrated from 141.9 to 266.3 mbsf and recovered 124.9 m (100%). The bit cleared the seafloor at 2255 h, ending Hole U1534A.

Hole U1534B started at 0245 h on 1 April. Core 1H recovered 1.5 m of sediment, but the core liner shattered and no clear mudline could be observed, so we decided to end the hole.

Hole U1534C started at 0345 h on 1 April. Cores 1H to 19H penetrated from the seafloor (606.3 m below sea level [mbsl]) to 168.0 mbsf and recovered 159.6 m (95%). Core 19H recovered 0.71 m and its core liner shattered, indicating that we had reached the limit of full-length piston coring, so we decided to end the hole at that point.

Hole U1534D started at 0045 h on 2 April. The purpose of this hole was to fill a stratigraphic gap and to provide more material for sampling in the upper part of the stratigraphy. Cores 1H to 3H penetrated from the seafloor to 28.5 mbsf and recovered 29.6 m (104%).

With operations completed at Site U1534, we transited in dynamic positioning mode (so that we did not have to raise the drill string back to the ship) 4 nmi east from 0515 to 0930 h to Hole U1535A (proposed Site SFSD-02A). The seafloor was determined by the Core 1H mudline to be 646.9 mbsl. Coring proceeded without difficulty until Cores 9H–11H, which were difficult to remove from the core barrel, so we switched to HLAPC coring with Core 12F at 88.5 mbsf. Cores U1535A-1H to 17F penetrated from the seafloor to 117.3 mbsf and recovered 112.4 m (96%). Having achieved sufficient stratigraphic coverage and considering the overall time

constraints for the expedition, we concluded operations at the Subantarctic Front Sites U1534 and U1535, and we started pulling up the drill string at 0330 h on 3 April. The bottom-hole assembly was laid down and the rig floor was secured for transit.

We started the voyage across the Southern Ocean to proposed Scotia Sea Site SCO-13A at 0848 h on 3 April. Iceberg conditions in the region of proposed Site SCO-13A were classified as “ice free” in the daily reports from the US National Ice Center. The first iceberg of the expedition was spotted at 1600 h at 56°20'S, 49°28'W. In the midmorning of 5 April we reduced speed because of icebergs in the general area and reduced visibility due to fog, but we were able to resume normal speed by late morning. The towed magnetometer was deployed during the transit in international waters. The 709 nmi transit to proposed Site SCO-13A in the Dove Basin study area took 2.8 d at an average speed of 10.5 kt.

During the transit we had observed that the 3.5 kHz subbottom profile contained a series of reflections down to about 100 mbsf, a notable level of detail not normally seen in such profiles. Based on this we decided to make two 3.5 kHz survey profiles over the site, each 4 nmi long along the site survey seismic lines. The survey confirmed the water depth and provided details of the shallow reflectors at the site. The thrusters were lowered at 0430 h on 6 April, ending the sea voyage.

The drill string was assembled and lowered to the seafloor at Site U1536 (proposed Site SCO-13A). A pig was pumped down to remove rust from the inside of the drill pipe, but it appears that it did not emerge from the end of the drill string. This caused the piston corer to misfire twice, and despite deploying a barrel with a center bit to try to remove any remaining obstruction, the piston corer misfired a third time. At midnight on 6 April, the drill string was being raised back to the ship in order to clear the obstruction.

## Science Results

All cores from Sites U1534 and U1535 were X-rayed and measured for physical properties. The core sections were then split, imaged, analyzed for magnetic susceptibility and color reflectance, and described. Discrete samples were taken for inorganic geochemical measurements and X-ray diffraction (XRD) clay mineral analyses. The stratigraphy at Site U1535 repeats the upper part of the stratigraphy at Site U1534, but is slightly more expanded. The two sites are 4 nmi from each other.

### *Lithostratigraphy*

The dominant lithologies at Sites U1534 and U1535 are greenish-gray silty clays, interbedded with clayey silts and clay layers. The most common biogenic components, sponge spicules and diatoms, generally comprise between 10% and 25% of the sediment. At both sites, calcareous microfossils such as nannofossils and foraminifers are concentrated in meter-scale layers, where

$\text{CaCO}_3$  concentrations reach up to 50 wt%. These layers are interpreted to have been deposited during interglacials, and are present down to about 110 mbsf in Hole U1534A.  $\text{CaCO}_3$  levels fall below 1 wt% from about 110 to 220 mbsf, and increase above 1 wt% from 220 m to the base of Hole U1534A. Several well-preserved macrofossils were found throughout the cores, including solitary cold-water corals, gastropods, and mollusk shell fragments. Ice-raftered clasts are present but rare.

### *Biostratigraphy*

Diatoms: While abundance and preservation (fragmentation and dissolution) are variable throughout the analyzed sections, diatoms occur in all sections with the exception of two core catcher samples near the base of Hole U1534A, which are barren of diatoms. Silicoflagellates, ebridians, and sponge spicules are also present with the diatoms. Samples were taken from Hole U1534B cores on the catwalk for studies of ancient diatom DNA.

Radiolarians: Radiolarians generally occur in high abundance and moderate to good preservation in Hole U1534A, with the exception of the 195–233 mbsf interval where radiolarians are rare and poorly preserved.

Palynology: 22 core catcher samples were analyzed from Hole U1534A for palynological content (dinoflagellate cysts, pollen, and spores). All samples yield well-preserved marine and terrestrial palynomorphs. Most of the dinoflagellate cysts and acritarchs identified are long-ranging, and nearly all of the samples contain some reworked specimens.

Microfossil groups from core-catcher samples in Hole U1534 indicate the following biostratigraphy: 0 to 80 mbsf is Holocene to middle Pleistocene in age; 80 to 120 mbsf is early Pleistocene, 120 to 235 mbsf is late Pliocene; and 235 mbsf to the base of Hole U1534A at 266 mbsf is early Pliocene. Possible hiatuses are present at ~80 and ~255 mbsf. Depths are approximate because of the ~10 m spacing between core catcher samples.

### *Paleomagnetism*

Paleomagnetic measurements were made to investigate the natural remanent magnetization (NRM) of 201 APC and HLAPC core sections from Hole U1534A, 111 sections from Hole U1534C, and 79 sections from Hole U1535A. Full-length APC cores were oriented using data from the Icefield MI-5 orientation tool. Normal polarity extends from the seafloor to at least 74.5 mbsf in Hole U1534A and to 73.2 mbsf in Hole U1534C. From 74.5 to ~120 mbsf in Holes U1534A and U1534C we were unable to confidently determine the polarity because directions become more scattered. We did not observe a clear Brunhes–Matuyama reversal or any interval of well-defined reversed polarity until 235 to 266 mbsf, where we observed two reversed intervals.

## *Geochemistry*

Pore water and headspace gas samples were taken on all full-length piston cores and every second half-length piston core from Holes U1534A and U1535A. Both holes have normal headspace gas depth profiles. There is relatively low salinity from ~30 to 150 mbsf, and the highest alkalinity (up to 30 mM) is at 20–30 mbsf, coinciding with the methane/sulfate transition zone.

## *Physical properties*

Values of gamma ray attenuation bulk density, magnetic susceptibility, and acoustic velocity were measured at 2.5 cm spacing, and natural gamma radiation at 10 cm spacing. X-radiograph images were obtained for all cores at Sites U1534 and U1535. Wet-bulk densities range from 1.5 to 2.2 g/cm<sup>3</sup>, with a mean value of 1.8 g/cm<sup>3</sup>. The amplitude of all physical properties variations is higher in the top 80 m of Hole U1534A compared to the underlying 80 to 266 mbsf. Two possible hiatuses in the stratigraphy likely correspond to previously identified discontinuities in the seismic profiles across the two sites.

## *Stratigraphic correlation*

A composite depth scale was created by correlating sequences from Holes U1534A, U1534C, and U1534D, and then a near-complete and representative splice section was constructed from those sequences. Detailed sedimentological logs were consulted in the process of splice construction to avoid inclusion of any obviously disturbed sections and/or sections with unique features (relative to the other holes).

## *Downhole measurements*

Four advanced piston corer temperature tool (APCT-3) formation temperature measurements were made with Cores U1534A-4H, 7H, 10H, and 13H. The two shallower measurements did not yield reliable results, so we made measurements at similar depths with Cores U1534C-4H and 7H. Two temperature measurements were made with Cores U1535A-4H and 7H. Combining the formation temperature measurements with the thermal conductivity measurements yields preliminary heat flow estimates of 49 mW/m<sup>2</sup> for Site U1534 and 41 mW/m<sup>2</sup> for Site U1535.

## **Outreach**

[joidesresolution.org](http://joidesresolution.org): We posted four blogs this week.

*Twitter* (<https://twitter.com/TheJR>): We posted 12 original tweets, including photos of the first days of coring and the first iceberg of the expedition.

*Facebook* (<https://www.facebook.com/joidesresolution>): We uploaded 11 posts, including posts linking to blog posts, and a Facebook Live interview with expedition scientist Vicky Peck.

*Instagram* ([http://instagram.com/joides\\_resolution](http://instagram.com/joides_resolution)): We uploaded five posts and three Instagram stories, including ice words of the day and video of dolphins swimming in the bow wave.

*Live Events:* We conducted video conferences with six groups, including a group of 200 elementary school students at Collegio de Purísima (Spain).

## **Technical Support and HSE Activities**

### *Laboratory Activities*

- Processed cores and samples from Sites U1543 and U1535.
- Dark mud-worms and persistent white flecks repeated in the same positions in multiple X-ray logger images. Mud residue was cleaned from the acrylic tube and the flat panel detector was cleaned and recalibrated, fixing the problem of artifacts in the images.
- On the X-ray image logger, the actuator arm and pusher were modified to keep section halves from rotating while run through the logger. Rotation of the section halves had been noticed as narrowing of the images.
- Replaced broken belt on Kappabridge KLY-4 magnetic susceptibility meter.
- After measuring cores on the superconducting rock magnetometer (SRM) from the first two sites, it was discovered that the IMS software had the SQUID calibrations and response lengths from the previous 2G SRM hard coded into the code, and upon software startup was writing these values to a new config file. In particular, the sign of the y-axis magnetometer data was reversed between the old and the new configurations. The correct SQUID values for the current SRM were replaced in the IMS code and tested. The scientists have corrected the SRM data for the first sites.
- Performed a 3.5 kHz sonar and magnetometer survey over proposed Site SCO-13. The survey consisted of two 3.7 nmi perpendicular crossing lines over the site at a speed of 6 kt.

### *Application Support Activities*

- Fixed a small bug in the IMS-SHIL code that prevented the sample length from being retrieved from the LIMS database.
- Fixed a small bug in the Velocity application that prevented users from saving data when using the manual-pick mode.
- Worked with paleomagnetists and physical properties technician to correct a bug that caused the SRM software to use old, erroneous calibration constants; looked for a bug

that causes the measurement-sequence to terminate prematurely when an offline-treatment is included in the sequence (work on offline-treatment bug is still in progress).

- Upgraded SCORS uploader to work with new file format for affine.table files produced by Correlator 3.0.
- Corrected bug in the RSC standard report that prevented users from using the bulk-download feature to download normalized spectral data and unnormalized spectral data.
- Trained Assistant Laboratory Officer and XRD technician to configure MUT to upload XRD data and include comments to designate which treatment was used.

#### *IT Support Activities*

- Resumed project to enable multifactor authentication for JR servers.
- Assisted technicians with troubleshooting orientation tool palm pilot data download issues.
- Finished installing monitor mounts in the user room and zoom room.
- Deployed new 24 inch monitors in Chemistry Laboratory, OPS office, Offshore Installation Manager office, and drill shack. Removed old monitors from those locations and prepared for return to IODP for surplus.
- Continued development of MCSZone Confluence space.
- Deployed new PC to science office to be used to process and view X-ray images.
- Installed Adobe Creative Cloud on Publications office PC but we are having issues with licensing. Troubleshooting is ongoing.
- New McKinley server has been imported and we are preparing to transfer AMS services from the old server to the new server.

#### *HSE Activities*

- Conducted weekly fire and abandon ship drill.
- Safety showers and eyewash stations were tested.