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

Site U1535 Summary

Background and Objectives

International Ocean Discovery Program (IODP) Site U1535 (proposed Site SFSD-2A) is located on the northern flank of a large trough, ~668 km east of the Magellan Straits, at 53°11.49′S, 58°38.60′W, in 647 m of water. The site is situated at common depth point 9220 on seismic reflection profile SGFI93-107. Site U1535 is the second of a pair of sites. The first, Site U1534 (proposed Site SFSD-3A), 8 km to the west, planned a more extensive coring program targeting the deeper part of the common stratigraphy at the two sites.

The primary objective at Site U1535 was to recover a continuous 120 m sedimentary section from the upper sequences of a contourite drift deposited on the northern flank of the east–west trending tough. The crest of the contourite drift is currently being deposited beneath the Subantarctic Front (SAF) at 600 m water depth. The drift is bathed with Antarctic Intermediate Water (AAIW) as it begins its northward penetration into the Atlantic Ocean. The principal scientific motivation to core this drift is to better understand the role of AAIW in climate change on millennial, glacial-interglacial, and longer term timescales. See the Site U1534 Summary for more detailed information about the objectives at this pair of sites.

Coring at Site U1535 aimed to recover the sediment unit between Reflectors A and B, which is thicker than the lateral extension of the unit at Site U1534, potentially including older sediments. Site U1534, conversely, was selected to target the most continuous and expanded sediments above Reflector A and below Reflector B.

Operations

After completing the 4 nmi transit east from Site U1534 in dynamic positioning mode, we arrived at Site U1535 at 0930 h on 3 April 2019. Hole U1535A started at 1200 h on 2 April. The seafloor was determined by the Core 1H mudline to be 646.9 m below sea level. Cores 9H–11H were difficult to remove from the core barrel, so we switched to half-length advanced piston coring for 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 started pulling up the drill string at 0330 h on 3 April. The bit cleared the rotary table at 0840 h on 3 April, ending Hole U1535A, and the rig floor was secured for the sea voyage to the Scotia Sea sites.

Principal Results

Hole U1535A contained several sequences of silty clays, interbedded with clayey silts and clay layers. The most common biogenic components, sponge spicules and diatoms, generally comprised between 10% and 25% of the sediment. Intervals containing high concentrations of calcareous nannofossils and other microfossils are interpreted to be interglacial sediments. Several well-preserved macrofossils were found throughout the cores, including solitary cold-water corals, gastropods, and mollusk shell fragments. Ice-rafted clasts are present but rare.

Species assemblages and biostratigraphic age markers are similar to those of Site U1534. We identified 12 diatom, radiolarian, and palynomorph biostratigraphic age events. Mid- to early Pleistocene biostratigraphic markers were recovered above Reflector B, and early Pleistocene markers were found in the two lowermost cores, beneath Reflector B. A downhole paleomagnetic transition from reversed to normal polarity in the two lowermost cores may represent the transition from the Matuyama Chron (C2r; 2.58 Ma) to the Gauss Chron C2An.1n, which is consistent with biostratigraphic constraints and the seismic stratigraphic relationship to Site U1534.

Interstitial water analyses show a typical diagenetic profile, similar to observations made at neighboring Site U1534, with the characteristic signal of sulfate reduction in the uppermost 20 m and increasing ammonium, alkalinity, and barium concentrations below. Total organic carbon (TOC), total nitrogen (TN), and calcium carbonate contents range from 0.4–1.4 wt%, 0.02–0.15 wt% and 0.1–49 wt%, respectively.

Two formation temperature measurements were made with Cores U1535A-4H and 7H. Combining the formation temperature measurements with the thermal conductivity core measurements yields a preliminary heat flow estimate of 41 mW/m^2.

The late Pleistocene interval at Site U1535 was more condensed than at Site U1534, with a 3 m thick pale-colored carbonate ooze that we interpret as Marine Isotope Stage (MIS) 11 occurring at 25 mbsf, compared with 40 mbsf at Site U1534. Reflector A in the seismic profile represents the foraminifer ooze of MIS 11. Visual core descriptions noted that transitions in and out of the MIS 11 foraminifer ooze and other interglacial intervals are abrupt relative to those at Site U1534, suggesting the presence of multiple nondeposition and/or erosional hiatuses. Biostratigraphic and paleomagnetic interpretation is limited by these hiatuses but is consistent with a mid- to early Pleistocene age of the sediments between Reflectors A and B. Reflector B occurs at 98 mbsf at Site U1535, based on the correlation to seismic profiles and changes in the physical properties records at this depth. At Site U1534, the oldest sediments recovered above Reflector B were <0.78 Ma, so the recovery of older sediments above Reflector B at Site U1535 shows that the uppermost unit of the drift onlaps onto Reflector B. It is also noted from the seismic data that the most distal part of the uppermost unit of the drift is truncated, consistent with the more common occurrence of hiatuses at Site U1535.

Records from Site U1535 will be most useful for understanding the dynamics of the evolution of the drift. The more continuous, generally higher resolution records from Site U1534 will be preferred for paleoceanographic studies from the drift.