

IODP Expedition 318: Wilkes Land Glacial History Week 6 Report (7–13 February 2010)

OPERATIONS

Operations this week consisted of coring at Sites U1358 (WLSEH-08A), U1359 (WLRIS-04A), and U1360 (WLSHE-09B).

Site U1358 (WLSHE-08A): We started RCB coring in Hole U1358A at 2245 hr on 6 February. While cutting Core U1358A-1R, an iceberg approached close enough to the vessel that we had to pull out of the seafloor at 0015 hr on 7 February. We moved 300 m SSW of the hole to allow the iceberg to pass. Core U1358A-1R had penetrated only 2.0 m and recovered 1.10 m (55%). After waiting 2.25 hrs for the iceberg to drift out of the area, we moved back over the site and started Hole U1358B-1R at 0250 hr on 7 February. RCB Cores U1358B-1R to 4R penetrated to 35.6 mbsf and recovered 8.0 m (22%).

While attempting to cut Core U1358B-5R, a drill collar connection failed and the lower stand of drill collars, mechanical bit release, assorted subs, bit, and core barrel was lost in the hole. The weather was forecasted to significantly deteriorate and we didn't want to remain in an area with such high concentrations of ice during the storm. So, we decided to move to a deeper water site, Site U1359 (WLRIS-04A), where the concentration of icebergs was very low. We departed Site U1358 at 1530 hr on 7 February. The total time on Site U1358 was 22.00 hours.

Site U1359 (WLRIS-04A): While departing the shelf, we had to negotiate around and through an assortment of pack ice and grounded ice bergs; these became less concentrated and finally disappeared as we moved off the shelf. As we arrived in the vicinity of Site U1359 at midnight, we experienced near gale force winds, rough seas, and visibility down to 4 nmi in freezing rain. We lowered the thrusters and stabilized near the site using GPS, but waited on the weather to improve until the next morning. The 73 nmi transit to Site U1359 was accomplished in 8.5 hours at 8.6 nmi/hr.

After seven hours, the weather conditions improved enough so that we could assemble the drill string to the seafloor. We started APC coring in Hole U1359A at 1800 hr on 8 February with bit at 3012 mbrf. Based on the recovery of the first core, the water depth is 3020.9 mbrf. Cores U1359A-1H to -17H penetrated to 145.4 mbsf and recovered 124.27 m (86%). Temperature measurements were made while taking Cores U1359A-4H, -7H, -10H, and -13H (29.1, 57.6, 86.1, and 114.6 mbsf, respectively). Non-magnetic core barrels were used for all piston cores after Core U1359A-1H, but were not oriented. After APC refusal, we deepened the hole with XCB Cores U1359A-18X to -22X from 145.4 to 193.5 mbsf and recovered 29.81 m (62%). Total recovery for Hole U1359A was 80%. Rather than continuing to deepen the hole with XCB, we decided stop so that we could core two more APC holes to provide a more complete section.

The bit cleared the seafloor at 1700 hr on 9 February and we offset the vessel 25 m to the WSW. We started coring Hole U1359B at 1815 hr with the bit at a depth of 3017 mbrf. The seafloor was established at 3018.8 mbrf. APC Cores U1359B-1H to -23H penetrated to 209.0 mbsf and recovered 183.59 m (88%). Non-magnetic core barrels were used for all APC cores. We then deepened the hole with the XCB. Cores U1359B-24X to 28X from 209.0 to 252.0 mbsf and recovered 15.33 m (36%). The total recovery for Hole U1359B was 79%. The bit was pulled clear of the seafloor at 2240 hr on 10 February.

The vessel was offset 25 m WSW of Hole U1359B. We started coring in Hole U1359C at 2340 hr on 11 February with the bit at a depth of 3020 mbrf. The seafloor depth was established at 3022.3 mbrf. APC Cores U1359C penetrated to 168.7 m and recovered 150.73 m (89%). We planned to stop coring at this time to be able to depart for high priority shelf sites so that we could take advantage of a forecasted period of good weather. We plan on returning to this site, so we did not retrieve the seafloor beacon at this time. The bit cleared the seafloor at 1620 hr and was back onboard at 2340 hr on 11 February. We departed for Site U1360 (WLSHE-09B) at 2345 hr on 11 February. The total time on Site U1359 was 89.25 hours.

Site U1360 (WLSHE-09B): The voyage to Site U1360 began in gale force winds and rough seas, but these slowly abated during the day. As we moved south, we began to observe numerous icebergs and we had to adjust speed and heading to adapt to conditions. Approximately 15 nmi from location we encountered an ice tongue comprised of pack ice and icebergs that blocked direct access to Site U1360. We had to detour ~30 nmi to the west to find a clear passage around the ice. The outside temperature of -5°C combined with the 35 knots winds created a wind chill around -20°C and ice began forming on the deck and the outside bulkheads.

We arrived at Site U1360 at 1800 hr on 12 February. However, we had to wait 5.25 hrs in dynamic positioning mode for two large icebergs in the immediate vicinity to move away. We were finally on site and starting to deploy the drill sting at 2315 hr on 13 February. We decided to use a shorter, 2-stand bottom-hole assembly (BHA) so we could reduce the time the rigid drill collars were above the seafloor. We did this to reduce the chances of repeating the drill collar pin failure that happened at Hole U1358B.

After the driller tagged seafloor with the bit at 506.0 mbrf, we started RCB coring in Hole U1360A at 0425 hr on 13 February. Cores U1360A-1R to -7R penetrated to 70.8 mbsf and recovered 7.04 m (10%). Due to the relatively hard seafloor, rotary coring proceeded slowly and carefully. Coring had to stop when large icebergs forced an early termination of the hole. We had started to prepare a free-fall funnel so that we could attempt to return to the same hole after the next severe storm. Unfortunately, the hole had to be abandoned due to the approaching iceberg before it could be deployed.

We departed Site U1360 at 0615 hr on 14 February. We plan on returning to this site, but are moving to deeper water to avoid riding out next intense low pressure system among the ice and in shallow water. This system is predicted to arrive Sunday evening and by

Monday will bring 50-knot winds with gusts up to 60 knots and poor visibility in snow flurries.

SCIENCE RESULTS

Science results this week cover the initial coring at Site U1358 (WLRIS-08A) and at Site U1359 (WLRIS-04A).

Site U1358 (WLSHE-08A): The primary objective at Site U1358 (WLSHE-08A) is to sample across the regional erosional unconformity WL-U8. This unconformity marks a distinct change in the geometry of the progradational wedge from low dipping to steeply dipping foresets. It is inferred to reflect a significant change in the late Miocene glacial regime - possibly the transition from wet-based dynamic to cold-based persistent ice sheet. We drilled two holes in the Antarctic continental shelf in a water depth of 499 m. Unfortunately, we were only able to penetrate to 35.6 mbsf before the drill collars failed and we had to abandon the hole. We then had to leave Site U1358 due to an approaching severe weather system, but hope to be able to return to sample across WL-U8.

Cores from Site U1358 recovered diamictites deposited either from floating ice or subglacially, with possible remobilization by glacial debris flows.

Samples from Core U1358B-1R contain well-preserved and abundant modern diatom assemblages; the remaining cores contain a sparse assemblage of mixed ages that are inferred to indicate moderate to severe reworking. Samples from Cores U1358B-1R through -4R contain very few radiolarians, which are mostly fragmented, and give an age of younger than late Miocene. Core 3R contains very rare dinocysts of Oligocene and younger age, with high amounts of reworked spores of Paleozoic-Mesozoic age.

Site U1359 (WLRIS-04A): The primary objective at Site U1359 (WLRIS-04A) is to obtain an expanded distal record of paleoceanographic and climate variability during the late Neogene and the Quaternary. This includes the middle Miocene climatic optimum and the transition from a dynamic to a persistent ice sheet, inferred to have occurred during the Late Miocene–Pliocene at the Wilkes Land margin. This site will also help document ice sheet stability during extremely warm events during the Miocene and Early Pliocene. So far, three holes have been cored at Site U1359 to a total depth of 252 mbsf. We intend to return to this site to RCB core the deeper part.

The three holes show a similar succession of lithofacies, with ~40 m of interbedded olive brown and olive grey silty clays (with diatom and foraminifera-bearing horizons). This unit overlies ~200 m of bioturbated diatom-bearing silty clays interbedded with silty clays that are mostly massive but contain periodic intervals of silt/fine sand lamina. Dispersed clasts with diverse lithologies occur throughout the entire section.

Paleomagnetic measurements are nearly completed and the magnetic stratigraphy is reasonably well defined and reproducible between the three holes. We are in the process

of correlating these to the geomagnetic polarity time scale. At least one hiatus is inferred between about 30 and 40 mbsf. We are working with micropaleontologists to develop a consistent age model. We believe we have a superb record spanning nearly all of the Pleistocene-Pliocene and the uppermost part of the Miocene.

Diatoms and radiolarians are abundant and well preserved throughout the section and provide a high-resolution middle upper Miocene to Pliocene-Pleistocene stratigraphy. Reworked Paleogene and Mesozoic-Palaeozoic spores are common throughout. Dinocyst species include those reworked from the Eocene, as well as typical Oligocene-Holocene proteroperidinioid dinocysts, in low concentrations. Planktonic and both calcareous and agglutinated benthic foraminifers are abundant in Core U1356A-1H to 5H; agglutinated foraminifers are sporadic below this level.

Twenty-one samples have been taken for inorganic geochemistry analyses of percent carbonate, C, N, and S contents, as well as major and minor element geochemistry. Seventy-three microbiology samples (whole round) were taken at Hole U1359B within the top 20 m. Direct cell counts to estimate viable biomass estimate are underway. In support of the microbiology program, 51 interstitial water samples were also taken from the top 20 m of Hole U1359B and are in the process of being analyzed for salinity, alkalinity, chloride content, anions, cations, nutrients, and main and trace elements.

In addition, twenty-five whole round samples were taken from the first seven cores from Hole U1359B for Optically Stimulated Luminescence (OSL) dating.

Changes in physical properties generally correspond to identified lithostratigraphic boundaries. Velocity and density slightly increase from 0 to ~45 mbsf while water content and porosity decrease (near the boundary between Lithostratigraphic Units I and II). From ~45 to 65 mbsf, density decreases but porosity and water content increase. Between 65 and ~125 mbsf, index properties exhibit no clear trend with depth; below ~130 mbsf the density exhibits another decrease.

Whole-round measurements of magnetic susceptibility, density, and natural gamma ray allow the stratigraphic correlation of the three adjacent holes at Site U1359. A preliminary composite record has been produced from the seafloor to 200 mcd. However, a few short gaps exist.

TECHNICAL SUPPORT AND HSE ACTIVITIES

This week, the technical staff supported the processing and data collection for remaining APC cores from Site U1357, the 5 RCB cores from Site U1358, and the 68 APC cores from Site U1359. A fire and boat drill was held on February 10 for the entire ship's complement.