IODP Expedition 318: Wilkes Land Glacial History
Week 5 Report (31 January – 6 February 2010)

OPERATIONS

Operations this week consisted of completing coring at Site U1356 (WLRIS-07A), coring at Site U1357 (ADEL-01B), and starting coring at Site U1358 (WLSHE-08A).

Site U1356: RCB Cores U1356A-97R to -106R penetrated from 910.2 to 1006.4 mbsf and recovered 41.98 m (44%). Total core recovery for the entire hole (0 to 1006.4 mbsf) was 350.13 m (35%). After coring was finished, we began preparing the hole for logging and raised the drill bit to 103 mbsf. While lowering the bit back down, the weather deteriorated to the point where we had to abandon the hole and we started to retrieve the drill string. After the drill string was recovered, the weather system had passed and the sea conditions began to improve. After the beacon was recovered, we began the transit to Site U1357 (ADEL-01B) at 0615 hr on 2 February.

Site U1357: Site U1357 (ADEL-01B) was the southernmost of the shelf sites - all of which are prone to ice coverage. Shortly after departing Site U1356, we began to encounter floating ice. The vessel speed was frequently adjusted to match visibility and ice conditions as we proceeded on a SE heading toward the site. We were able to negotiate through large concentrations of ice with the benefit of a clear and sunny day providing excellent visibility. The 218 nmi transit to Site U1357 took 25.7 hours at an average speed of 8.5 nmi/hr. We were positioning over Site U1357 at 0800 hr on 3 February. After a short wait to evaluate the movement of proximal ice, we began assembling the APC/XCB drilling assembly.

Coring at Hole U1357A started at 1445 hr on 3 February with seafloor depth of 1014.8 mbsl. However, the extremely diffuse boundary between bottom water and seafloor sediment precludes accurate definition of water depth using a standard shipboard sonar system; most coring systems (including the APC) typically also do not recover this boundary. APC Cores U1357A-1H to -21X penetrated to 186.6 m and recovered 183.87 m (99%). The last APC core (Core U1357A-20H) was an incomplete stroke. We then took a single XCB core from 185.6 to 186.6 mbsf and this bottomed out in diamict. Coring was interrupted for four hours when an iceberg approached close to the ship. The bit cleared the seafloor at 1120 hr on 4 February.

After offsetting the ship 50 m to the east, we started coring in Hole U1357B at 1345 hr on 4 February. APC Cores U1357B-1H to -19H penetrated to 170.7 mbsf and recovered 172.44 m (101%). The bit cleared the seafloor at 0340 hr on 5 February.

Hole U1357C, offset 25 m west of Hole U1357A, started coring at 0645 hr on 5 February. APC Cores U1357C-1H to -11H penetrated to 103.8 mbsf and recovered 110.7 m (107%). Once again, coring had to be suspended because of the proximity of several icebergs. This time, however, the ice passed close enough that we had to abandon the hole so we could offset the ship 2.8 km to the SE. The bit cleared the seafloor at 1358 hrs on 5 February and we had to wait until the next morning to retrieve the beacon.

Site U1358 (WLSHE-08A): The transit to our next site began at 0900 hr on 6 February. We wanted to core at Site WLSHE-09A, but it was decided from visual and radar observations that there was too much floating ice in the vicinity for safe operations – especially considering the severe weather predicted for late 7 February. We continued past WLSHE-9B to WLSHE-08A – a location 22 nmi to the northeast of WLSHE-09A and closer to open waters.

We were positioning over Site U1358 (WLSHE-08A) at 1730 hr on 6 February. The 93 nmi transit was accomplished at an average speed of 10.9 nmi/hr. The drill string was lowered to the seafloor, but we had to wait to start coring for 1.3 hours as an iceberg moved through the drilling area. We tagged the seafloor with the bit at 512.0 mbrf and started RCB coring in Hole U1358A at 2245 hr on 6 February.

SCIENCE RESULTS

Science results this week cover the final coring at Site U1356 (WLRIS-07A) as well as all three holes cored at Site U1357 (ADEL-01B).

Site U1356 (WLRIS-07): As mentioned last week, the primary objective at this site was to recover a distal record of the first arrival of glaciers to the eastern Wilkes Land margin by sampling sediments across a regional unconformity in the seismic data, WL-U3, which is interpreted to separate pre-glacial strata below from glacial strata above.

This week we described cores from 782 to 1006.4 mbsf. Three additional Lithostratigraphic Units were identified; a total of ten units have been identified. Unit VIII consists of bioturbated claystones (some of which are calcareous) and laminated claystones, indicating hemipelagic sedimentation with periodic bottom current sorting. Unit IX (879.7 to 948.8 mbsf) is characterized by highly contorted claystones and coarse grained deposits inferred to be emplaced by gravity flows. Unit X (948.8-1000.1 mbsf) is characterized by bioturbated claystones with subordinate stratified siltstone and sandstone, indicating hemipelagic sedimentation with minor influence of bottom currents and gravity flows.

Samples from Cores U1356A-95R through -106R were examined for palynomorphs, siliceous microfossils, and foraminifers. The abundances of protoperidinioid dinocysts decline dramatically from Core U1356A- 94R downwards and the dinocyst assemblages are dominated by in situ early middle Eocene dinocysts; early Eocene dinocysts are dominant below Core U1356A-100R. Sporomorphs are present in all samples investigated, with generally higher abundances than further up in the succession. Sporomorph assemblages are characterized by well-preserved Nothofagus pollen grains, bisaccates and spores. No indication of reworking has been found. Radiolarians are present, preserved both in silicified and pyritized form, however, no age diagnostic taxa were detected. Foraminifers are dominated by agglutinated forms and characterized by low diversity and abundances; the foraminifer samples also yielded fish teeth. Diatoms occur as pyritized fragments and provide only limited age information.

Site U1357 (ADEL-01B): This site was designed to obtain an ultra-high resolution Holocene record by triple coring an ~200 m-thick sedimentary drift deposit overlying an inferred glacial diamict. Data from these samples will help assess the forcing factors (solar, ocean-atmosphere interaction, and volcanic) responsible for climate change over the past 10,000 years and their influence on climate and oceanographic processes in the Southern Ocean. Development of high-quality, high-resolution Holocene climate records from the East Antarctic margin is a key step toward understanding the circum-Antarctic and Subantarctic response to climate forcing and addressing similarities, differences, and links to the global record as well as nearby ultra high resolution ice core records. These data will help us evaluate the response of East Antarctic sea ice as well as the Ice Sheet (EAIS) and margin to global warming.

Three holes were cored at Site U1357. Hole U1357A recovered 186.6 meters of diatomaceous ooze and penetrated the underlying last glacial diamict. The lowermost 10 meters contains increasing amounts of terrigenous debris towards the base, mostly silt, with some sand and gravel near the base of the hole. We used the APC for all cores except for Core U1357A-21X, which recovered 12 cm of the underlying diamict. Recovery was generally greater than 100%, mainly because of gas-induced expansion. Cores from Hole U1357A were split and described after running through the whole-round track systems. Discrete samples (10 cm^3) for foraminifera were taken at 10 cm intervals to prevent dissolution that had been observed in previous Adelie drift cores. Hole U1357B is located 50 meters east of the first hole and recovered 172.4 m of core. Gas-induced core expansion was reduced by immediately drilling small holes in the plastic core liner. Although this core did not recover the basal diamict, it likely overlaps the section from Hole U1357A down to at least 170 mbsf. After processing the core sections from Hole U1357B through the whole-round track systems, they were not split but sealed in shrink-wrap with oxygen absorbers within 24 to 36 hours. Hole U1357C was cored 25 meters west of Hole U1357A and 110.7 meters of diatomaceous ooze was recovered before the hole was abandoned due to approaching icebergs. A large number of whole rounds samples were taken from the first two cores in Hole U1357C for age dating as well as geochemical and microbiological studies. Less frequent whole-round samples for dating and microbiologic plugs were taken in the deeper cores from Hole U1357C. The whole-round sections were treated similar to those from Hole U1357B.

Three Lithostratigraphic Units were identified in Hole U1357A. The uppermost 176 m consists of diatom ooze. This overlies a ~10-m-thick unit of clay-bearing diatom ooze. The base of the succession consists of carbonate-cemented diamictite with clasts of various lithologies.

Routine core catcher paleontology samples were not taken from the laminated diatom oozes to preserve a more complete stratigraphy for postcruise investigation. Samples were collected at section breaks whenever core expansion pushed material out of the core liner. Samples taken from Cores U1357A-1H to -9H were examined for siliceous microfossils, foraminifers, and palynomorphs. All section break samples yielded

abundant diatoms exhibiting a diverse Holocene assemblage, with trace to rare silicoflagellates and radiolarians. Samples from discrete light and dark lamina indicate that the dark lamina generally contain a more diverse assemblage. Sieved splits contain benthic and planktonic foraminifers as well as fish skeletal debris. These samples also yielded rich, highly diverse palynomorph associations with very good preservation; these are dominated by protoperidinioid dinoflagellate cysts and zooplankton remains.

Paleomagnetic measurements on Hole U1357A archive halves suggests that we can remove the drill string overprint by demagnetization to 15-20 mT and efforts are underway to remove data influenced by deformation and gas-induced voids. The data might contain an unprecedented Holocene secular variation record although several issues must be addressed prior any final interpretation. Lack of sufficient susceptibility is complicating our ability to normalize the intensity data to obtain a relative paleointensity record.

Samples for geochemical analyses of carbonate, C, N, and S were taken at a frequency of ~2 samples/core from Hole U1357A. A subset of these samples will also be analyzed for major and minor elements. Sixty microbiology samples were taken from Hole U1357C - the majority are whole-round samples <20 mbsf. Direct cell counts will be conducted to estimate viable biomass. Forty-five interstitial water samples were also taken from the upper 20 mbsf to complement the microbiologic studies. The pore water from these samples is being analyzed for salinity, alkalinity, anions, cations, nutrients, and main and trace elements.

The physical properties measurements of whole-round sections are highly impacted by both the extreme concentration of diatoms in the sediments as well as pervasive gas expansion. Therefore, density and velocity data are of very poor quality (or lacking) and magnetic susceptibility is at or below the noise level. Stratigraphic correlation between the three holes at Site U1357 is problematic due to the nature of the data available shipboard. A composite section may not be possible with these shipboard data and may have to be resolved with shorebased data.

Discrete moisture and density analyses of are of special importance for this site. Physical properties generally reflect the nature of these Holocene sediments and show typical density, porosity, and moisture content trends with depth characteristic for diatom ooze from the seafloor to ~160 mbsf. At that depth, porosity, moisture content, and void ratio exhibit a sudden shift to slightly higher values until the bottom of the hole.

TECHNICAL SUPPORT AND HSE ACTIVITES

This week, the technical staff supported the processing and data collection for the final 14 RCB cores from Site U1356 and 51 APC cores from three holes at Site U1357 that recovered 467 m of sediment in under 48 hrs. Core expansion as well as intensive catwalk sampling in the third hole required an all hands effort. A fire and boat drill was held on 2 February for the entire ship's complement.