IODP Expedition 318: Wilkes Land Glacial History

Site U1361 Summary

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Site U1361 (WLRIS-05A) is located in the continental rise at 3466 m water depth. Similar to Site U1359, the main objective at Site U1361 was to provide a history of climate and paleoceanographic variability record from the middle Miocene to the Pleistocene and to test the stability of the East Antarctic Ice Sheet during extreme warm periods (e.g., Miocene Climate Optimum, early Pliocene, and Pleistocene Isotopic Stages MIS 31 and MIS 11). Drilling at this site targeted the timing and nature of deposition of the upper seismic units (i.e., above the WL-U6 unconformity) defined on the Wilkes Land margin (De Santis et al., 2003; Donda et al., 2003). Within these units, a shift in sedimentary depocenters from the continental rise to the outer shelf is observed, possibly corresponding with the transition from a dynamic wet-based to a more persistent cold-based EAIS (Escutia et al., 2002; De Santis et al., 2003), which is inferred to occur during the late Miocene–Pliocene (Escutia et al., 2005; Rebesco et al., 2006). At Site U1361 unconformities WL-U6, WL-U7 and WL-U8 lie at about 5.13s, 5.03s, and 4.78s two way travel time (TWTT), respectively (about 385, 300 and 100 mbsf, respectively).

Site U1361 is located on the right (east) levee of the Jussieau submarine channel downstream from Site U1359. The levee relief (measured from the channel thalweg to top of the levee) at Site U1361 is about 195 m. The fine-grained components of the turbidity flows traveling through the channel and hemipelagic drape are inferred to be the dominant sedimentary processes building these levees (Escutia et al., 1997; 2000; Donda et al., 2003). Bottom-currents can further influence sedimentation in this setting (Escutia et al., 2002; Donda et al., 2003). The record from Site U1361 should be complementary to the record from Site U1359. Similar depositional environments were cored during ODP Leg 178 in the Antarctic Peninsula (Barker, Camerlenghi, Acton, et al., 1999) and ODP Leg 188 in Prydz Bay (O'Brien, Cooper, Richter, et al., 2001).

Two holes were drilled at Site U1361. Hole U1361A reached a total depth of 388.0 meters below sea floor (mbsf), using the Advanced Piston Corer (APC) system to refusal at 151.5 mbsf, followed by Extended Core Barrel (XCB) drilling to the bottom of the hole at 388.0 mbsf. Hole U1361B reached 12.1 mbsf using the APC. Five lithofacies (designated A through E) were identified at Site U1361 and, based on their distribution in Hole U1361A, two lithostratigraphic units are defined. Facies A and B consist of clays and silty clays with common diatoms and foraminifera, and rare dm-scale sets of mm- to cm-scale silt and clay laminae. These facies are restricted to the interval between 0.0 and 34.9 mbsf (Lithostratigraphic Unit I). Facies A and B were deposited in hemipelagic depositional environments, with isolated sets of silt and clay laminae indicating occasional sedimentation from low-density turbidity currents or saline density flows in a distal levee setting (Escutia et al., 2008). Facies C and D are strongly bioturbated silty clays and diatom/nannofossil oozes with intervals containing dispersed clasts. Facies E consists of laminated clays. Facies C through E are present between 34.9 and 386.3 mbsf (Lithostratigraphic Unit II) and are typical of contourite facies associations, although down-slope currents possibly contributed sediment as well. Samples U1361A-1H-CC through -41X-CC (1.5 to 386.31 mbsf) were analyzed for microfossils. Diatoms and radiolarians provide good age-control for Hole U1361A, resolving an uppermost Pleistocene through uppermost Middle Miocene sedimentary succession with no major breaks in sedimentation.

Miocene diatom assemblages at Site U1361 are indicative of productive, seasonally variable, open marine conditions. Fluctuations in the abundance of marine benthic and tychopelagic taxa such as *Cocconeis* spp., *Diploneis* spp., *Paralia sulcata*, stephanopyxids and *Trinacria excavata* may indicate pulses of shelfal material to the drill site. The presence of well preserved benthic foraminifers in Sample U1361A-34X-CC (321.07 mbsf) suggests that depositional settings were favorable for calcite preservation (i.e., not corrosive) for brief intervals in the Miocene. The persistent presence of reworked Mesozoic/Paleozoic sporomorphs within the palynological associations suggests ongoing erosion in the hinterland.

Late Neogene diatom assemblages from sediments drilled at Site U1361 are typical Southern Ocean open water taxa, with variable abundances of benthic, neritic and sea ice-associated diatoms, indicating a high nutrient-high productivity, sea ice-influenced setting throughout the late Neogene. High abundances of reworked sporomorphs within the palynological associations indicate strong erosion in the hinterland. Dinocysts are absent during this interval. The preservation of planktonic foraminifers in the Pleistocene indicates that bottom waters were favorable to the preservation of calcium carbonate.

Paleomagnetic investigations at Site U1361 document a complete section from the top of Chron C2n to the top of Chron C3n. Below Chron C2n the recovered core was quite disturbed and there is no complete analysis of the discrete samples as of yet. The lower portion of Hole U1361A can plausibly be correlated to the bottom of Chron C5n to C5An.

Forty samples from Hole U1361A were taken for analyses of percent carbonate, carbon, nitrogen and sulfur content, as well as major and trace element analyses. Due to technical problems with the ICP-AES no major and trace element analyses could be obtained. $CaCO_3$ contents for most samples are well below detection limit (<1 wt%). Between 313.96 and 342.04 mbsf, however, carbonate contents increase to 12.1 - 24.8 wt%. This matches the recognition of nannofossil-bearing clays constituting one of three major facies below 313.2 mbsf (Unit IIb; see Lithostratigraphy section). Carbon, nitrogen and sulfur contents were measured on 15 selected samples covering the full range of $CaCO_3$ contents (0–24.8 wt%). All concentration levels are very low (i.e., <0.5 wt% C, <0.03 wt % N, <0.02 wt% S), except for the four samples with high calcium carbonate contents. Taken together with the $CaCO_3$ measurements, these samples yield total organic carbon concentrations below 0.3 wt%, which is within the error or the respective measurements.

The physical properties program for Site U1361 include routine runs on the whole round multi-sensor logger, which includes the gamma-ray attenuation density (GRA), magnetic susceptibility, and *P*-wave velocity logger sensors, as well as natural gamma radiation measurements. *P*-wave velocity measurements were also analyzed and samples were taken and analyzed for moisture, density, and porosity. Thermal conductivity measurements were made in one section of all cores. The magnetic susceptibility data exhibit relatively high amplitude variations and this apparent cyclicity at several scales occurs especially in the upper 165 mbsf and between 305 mbsf and the bottom of the hole. There are two intervals with reoccurring relatively lower magnetic susceptibility units between 165 to ~185 mbsf and between 265 to 305 mbsf. The variations in GRA density reflect the regular fluctuations in lithology and porosity. The relative moisture content varies between 63 to 22 wt% and porosity from 82 to 42% with gradual decrease with increasing depth and overburden pressure. A common feature of density, porosity, and water content records of Site U1361 is a slight change to higher gradients below 330 mbsf that occurs within lithostratigraphic Unit IIb.

Downhole Logging operations started after a successful reentry of Hole U1361A, which had been left temporarily to allow an iceberg to pass. Runs with the triple combo, followed by the FMS-sonic were successful. The downhole logs at Hole U1361A have high-amplitude 1-5-m-scale variability superimposed on a downhole compaction trend. The character of the logs changes gradually downhole, with no major steps in the base levels, so the entire logged interval was assigned to one logging unit. It is likely that Milankovitch band variability at eccentricity and possibly obliquity periods is recorded at Site U1361. The downhole measurements at Site U1361 included four APCT-3 deployments in Hole U1361A. The thermal resistance was calculated over the intervals overlying the APCT-3 measurements, and the resulting linear fit of the temperature gives the heat flow value of 58.2 mW/m^2 .

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