IODP Expedition 318: Wilkes Land Glacial History

Site U1355 Summary

19 February 2010

The primary objective at Site U1355 (WLRIS-06A) was to core across the WL-U3 unconformity to obtain the timing and nature of the first arrival of the ice sheet to the Wilkes Land continental margin in a distal setting. Site U1355 is located at the transition between the continental rise and the abyssal plain in a water depth of 3729 m.

Multichannel seismic reflection profiles crossing Site U1355 image three of the Wilkes Land margin regional unconformities WL-U3, -U4, and -U5. Unconformity WL-U3 is observed at ~782 m (5.95ms TWTT) and was interpreted to separate pre-glacial strata below from glacial strata above. Thus, coring across WL-U3 unconformity was intended to document the first arrival of the ice sheet to the Wilkes Land continental margin. This "onset" of glaciation is presently inferred to have occurred during the earliest Oligocene.

Site U1355 was also designed to provide a distal record of Oligocene to the Pliocene(?) glacial/interglacial (i.e., colder vs. warmer) and ice sheet variability. Regional unconformity WL-U5 is imaged in the seismic data at ~709 m (5.6 s TWTT). WL-U5 represents a major shift in continental rise sedimentation with the onset of thick levee deposits above the unconformity. Coring across WL-U5 aimed to document the timing, nature, and cause of this shift in sedimentation.

Guided by the regional seismic interpretations, Site U1355 is located where the uppermost sedimentary section is relatively thin, or has been eroded, so that WL-U3 could be reached at a shallower depth in contrast to other locations offshore the Wilkes Land margin.

Based on the seismic facies at Site U1355, the lithologies expected were fine-grained distal turbidites, contourites and hemipelagites (Escutia et al., 1997, 2000, 2002; De Santis et al., 2003; Donda et al., 2003). This interpretation was supported by the sediments recovered from DSDP Site 269 (Hayes and Frakes, 1975) located on the abyssal plain ~280 km seaward from U1355.

Four cores from one hole were obtained at Site U1355. Cores U1355A-1R to 4R penetrated from 0 to 31.7 mbsf and recovered 14.95 m (47%). The stratigraphic integrity of most of the core was highly compromised by drilling disturbance. The sediments are composed of angular igneous and metamorphic fragments. These are unconsolidated clast-supported, moderately-to-well sorted, sandy granule-pebble conglomerates grading upwards into well-sorted fine, crudely stratified sands. One 3-cm thick interbed of dark greenish gray, diatom-bearing, silty clay was preserved between two upward fining units. The mechanism for the formation of the upward fining beds is through gravity flow, most likely a high-density turbidity current.

Samples from Hole U1355A were analyzed for siliceous microfossils, foraminifers and palynomorphs. Core catcher samples from Cores U1355A-1R to 4R and additional samples from clay-rich clasts within the cores were analyzed for diatoms. The core material yielded an abundant Antarctic flora dominated by *Fragilariopsis kerguelensis* and *Thalassiosira lentiginosa*. The association of these typical Pleistocene-Holocene Antarctic diatoms along with common *Actinocyclus ingens* and *A. ingens* var. *ovalis* indicates an age no older than late Pleistocene. Reworking from Miocene and Eocene material was recorded. A sample from the top of the hole yielded a rich and diverse modern (Holocene) Antarctic diatom assemblage. Radiolarians typical of late Pleistocene-Holocene Antarctic waters were also found in the core-catchers and seafloor samples with an overall low abundance. The seafloor sample yielded a low diversity planktonic foraminifer assemblage dominated by *Pachyderma neogloboquadrina* indicating an age <9.2 Ma. Palynomorphs were recorded in the seafloor sample and Samples U1355A-1R-CC and -4R-CC. Notable finds included Holocene organic walled dinoflagellate cysts (dinocysts), foraminifer linings, copepod eggs, besides reworked late Eocene dinocysts, and reworked Paleogene and/or Cretaceous spores and pollen.

The physical properties program for Hole U1355A cores included non-destructive measurements of gamma-ray attenuation densitometer (GRA) bulk density, magnetic susceptibility, natural gamma-ray emission (NGR) and P-wave velocity on whole-round core sections. Whole-round and section-half core logging measurements are significantly affected by poor core quality and the data are therefore compromised. Magnetic susceptibility values are relatively high reflecting the lithologic composition of the

individual clasts in the gravels and sands. The silty, diatom-bearing clay clasts are characterized by pronounced lower magnetic susceptibility, bulk density and sonic velocity values, but higher natural gamma ray counts. The P-wave velocities increase from 1800 m/s at the seafloor to more than 1920 m/s at the base of Core U1355A-2R.

In summary, operations at Site U1355 revealed that the nature of the seafloor was not the expected fine-grained sediments. After failing to core into the seafloor with the APC, the RCB system was tried, which yielded 31.7 m of Pleistocene to Holocene unconsolidated coarse gravels and sands. The nature of the sediment prevented any further advance. We decided to abandon Hole U1355A and move to the alternate Site U1356 (WLRIS - 07A) where we could achieve the same scientific objectives.

References

De Santis, L., Brancolini, G., Donda, F., 2003. Seismic-stratigraphic analysis of the Wilkes Land continental margin (East Antarctica). Influence of glacially-driven processes on the Cenozoic deposition. Deep-Sea Research. Part 2. Topical Studies in Oceanography 50 (8–9), 1563–1594.

Donda, F., Brancolini, G., De Santis, L., Trincardi, F., 2003. Seismic facies and sedimentary processes on the continental rise off Wilkes Land (East Antarctica). Evidence of bottom current activity. Deep-Sea Research. Part 2. Topical Studies in Oceanography 50 (8–9), 1509–1528.

Escutia, C., Eittreim, S., and Cooper., A.K., (1997). Cenozoic sedimentation on the Wilkes Land continental rise, Antarctica. In: C.A. Ricci (Ed.) The Antarctic Region: Geologic Evolution and Processes. *Terra Antarctica*, 791-795.

Escutia, C., Eittreim, S.L., Cooper, A.K., and Nelson, C.H., (2000). Morphology and acoustic character of the Antarctic Wilkes Land turbidite systems: ice-sheet sourced versus river-sourced fans. *Journal of Sedimentary Research*, Vol. 70, No. 1, p. 84-93.

Escutia, C., Nelson, C.H., Acton, G.D., Cooper, A.K., Eittreim, S.L., Warnke, D.A., and Jaramillo, J. (2002) Current controlled deposition on the Wilkes Land continental rise. In D. Stow et al. (eds.): Deep-Water Contourite Systems: modern drifts and ancient series, seismic and sedimentary characteristics. *The Geological Society of London, Memoirs,* 22, 373-384.

Hayes, D.E., Frakes, L.A., et al., 1975, Initial Reports of the Deep Sea Drilling Project, v. 28, Washington (US Government Printing Office), 1017 pp.