

## Calcareous nannofossil evidence for Marine Isotopic Stage 31 (1Ma) in ANDRILL MIS Core (western Ross Sea, Antarctica)

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During the austral summer 2006, the ANDRILL Program recovered a 1285-m-long succession of cyclic glaciomarine sediments from the McMurdo Ice Shelf (MIS). The aim of the MIS Project was to obtain continuous Neogene (c.0-10Ma) glacial, glaciomarine, volcanic and biogenic sediments that have accumulated in the region of the MIS (Ross Sea), nourished by ice flowing from the East Antarctic Ice Sheet (EAIS) outlet glaciers in the Transantarctic Mountains.

The MIS AND-1B drill core represents the longest and most complete (98% recovery) geological record from the Antarctic continental margin to date, and will provide a key reference record of climate and ice-sheet variability through the Late Neogene; detailed investigations of this record will contribute for improving our knowledge of Antarctica's influence on global climate.

Preliminary on-ice analysis of the smear slides of the Andrill core revealed calcareous microfossils (dinoflagellates, calciosponge spicula and small foraminifera) occurring with variable concentrations. The presence of thoracosphaerid fragments in the smear slides of the first 600mbsf (Quaternary), probably belong to the species *Thoracosphaera saxea* (Stradner, 1961) and *T. heimi* (Kamptner, 1941) and other, potentially undescribed, species (Villa & Wise, 1998), suggesting either a peculiar adaptation to this environment, due to their ability to develop cysts, or warmer conditions at the time of their deposition, or a combination of both. However, they represent an additional element to use, along with the other proxies for inferring palaeoenvironmental conditions of the core.

Subsequent shore-based analyses of 100 samples from 86-96mbsf revealed for the first time the presence of Pleistocene coccolithophorids at these high southern latitudes (77°S), including: *Cocco. pelagicus*, small *Gephyrocapsa*, *Retic. asanoi*, *Pseudoemil. lacunosa*, *Dictyo. productus*, *Retic. sp.*, *R. minutula*, *Thoraco. spp.* Tertiary reworked species include: *Discoaster sp.*, *Retic. hampdenensis*, *R. pseudoumbilica*, *Dictyo. antarcticus*, *Cyclicargo. floridanus*, *Geminilith. rotula*, *Transverso. sigmoidalis* and the Upper Cretaceous *Rein. levis*. As the lower temperature limit for living calcareous nannoplankton is 2.5°C, the presence of nannofossils from 86 to 96mbsf, though rare, is an indication of ice-free conditions and sea surface temperatures warmer than today in the Ross Sea. The presence of numerous volcanoclastic units and bio-siliceous sediments from 86.6 to 92.5mbsf indicate an extended period of open-water conditions, with no sea ice beyond the calving line.

An  $^{40}\text{Ar}/^{39}\text{Ar}$  age of  $1.015 \pm 0.004$  Myr on pumice at 85.20mbsf confirms the age assignment given by diatom biostratigraphy (1.07Ma) for this interval. Accordingly, the

short normal magnetozone between 84.97 and 91.13mbsf is correlated with the Jaramillo Subchron (C1r.1n; Wilson *et al.*, 2006).

The presence of nannofossils in the biogenic interglacial sediments is consistent with a warm episode of surface waters and open-marine conditions during the Jaramillo Subchron, at ~1Ma, which corresponds with Marine Isotope Stage 31 (Naish *et al.*, 2007). The 'superinterglacial' associated with Marine Isotope Stage 31 was the last significant warm interglacial of the obliquity-dominated world, and may represent a precursor to the high-amplitude, eccentricity-dominated cycles that followed the mid-Pleistocene climate shift. Climate proxies from other studies around Antarctica, like nannofossils and oxygen isotope stratigraphy at ODP Site 1165 (Villa *et al.*, 2008), and the presence of *Thoracosphaera* in a shelly carbonate sequence at Cape Roberts 1 (Villa & Wise, 1998), also support the idea of a warming event during this time, suggesting that it was areally extended around the Antarctic Continent, implying a total or partial collapse of the MIS. The warm interval during the Jaramillo Subchron shows that these areas were more climatically dynamic than previously thought and calls into question the notion that the EAIS has remained in a stable polar condition since the late Neogene. The warm surface water event reported here is especially significant, given its proximal position to the Antarctic ice sheet.

### References

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