Upper ocean variability during the mid-Miocene Climatic Optimum: First palynological results from the IODP Expedition 374 (Ross Sea)

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IODP Expedition 374 overarching goal

International Ocean Discovery Program (IODP) Expedition 374 to the Ross Sea (January to March 2018) was designed to **investigate the relationship between climatic/oceanic change and the Western Antarctic Ice Sheet (WAIS) evolution through the Neogene and Quaternary[1]**.

Five sites were cored (Figs. 1 and 2). **Site U1521** was drilled in the Pennell Through, in the mid to outer-shelf of the Ross Sea (562 m water depth) and will provide unprecedented insight into the environmental change of the Antarctic continental shelf and WAIS during the early and middle Miocene (~ 21 – 14 Ma). The warmest interval of the last 24 Ma**, the mid-Miocene Climatic Optimum (MCO ~ 17-15 Ma[2]**), a potential analogue for future climate, can be studied at high resolution a this Site. Portions of the East Antarctic Ice Sheets were unstable during the MCO, favoured by **contact with warm ocean waters[3]**

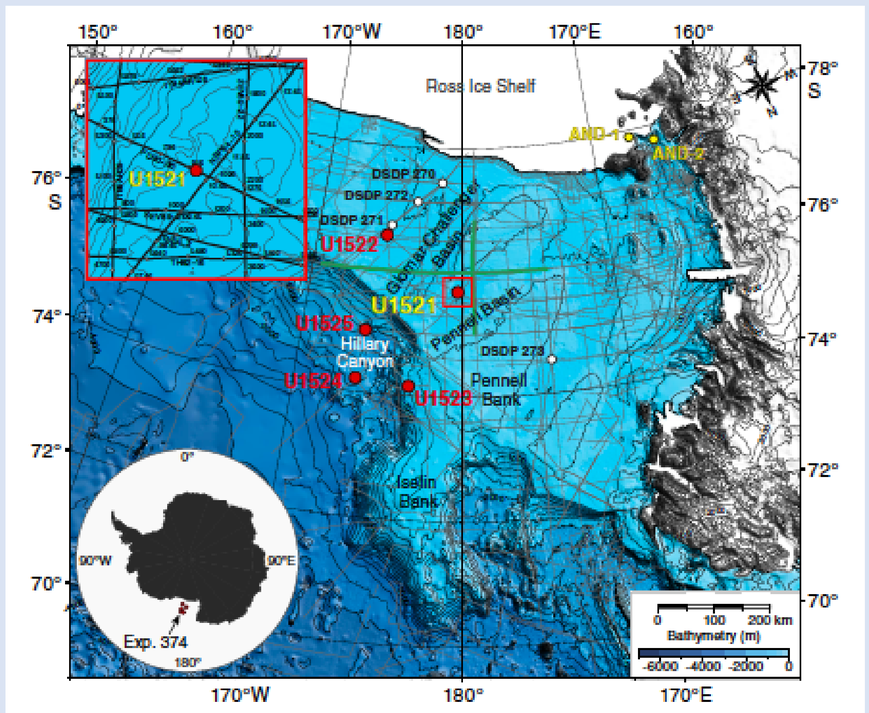
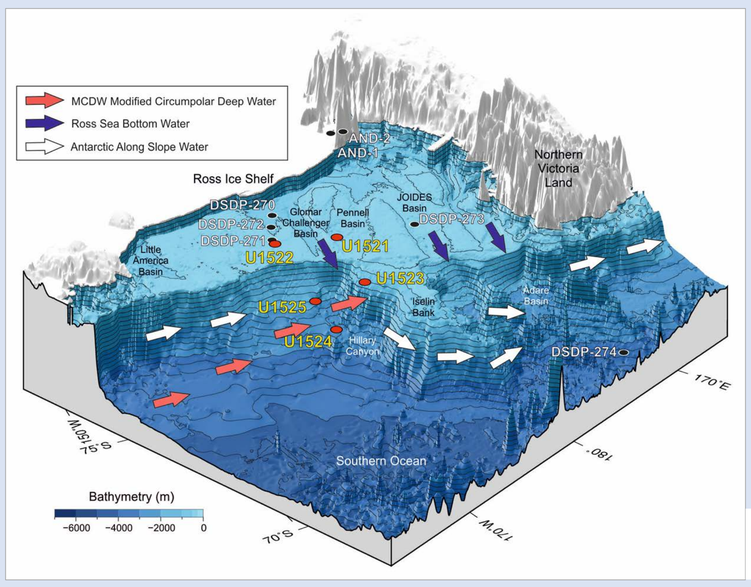


Figure 1: Location of the Expedition 374 drill-sites in the Ross Sea. Site U1521, object of this study, is indicated in yellow [1]

How (un)stable was the (Western) Antarctic Ice Sheet during the MCO and what was the role of the ocean? How did the Ross Sea oceanography change during this past warm episode?



Present-day Ross Sea oceanography: its importance for deep water formation, the global circulation and as buffer for basal melting.

The Ross Sea, due to its extensive ice cover is extremely important **for deep water formation**, which ventilate the deep ocean and sustain the global thermohaline circulation[4, 5]. The abundant sea ice production from the ice sheets surrounding the Ross Sea benefits ice shelf extension and the cold, dense water **blocks the intrusion of warm Circumpolar Deep Water (CDW), decreasing basal melting** (Figure 2).

Figure 2: Location of the IODP Expedition 374 drill-sites in the Ross Sea and indication of the major water masses circulating around the sites. Sites of previous drilling expeditions are indicated in grey[1].

Dinoflagellate cysts (fossil remains dinoflagellates) in sediments are used to reconstruct surface water conditions.
Present-day dinocyst assemblages close to the Antarctic margin are almost exclusively composed by few species of brown heterotrophic dinocysts (sea ice and high productivity). North of the Subantarctic front (SAF) transparent, phototrophic cysts are dominant (oligotrophic warm waters, Figure 3)

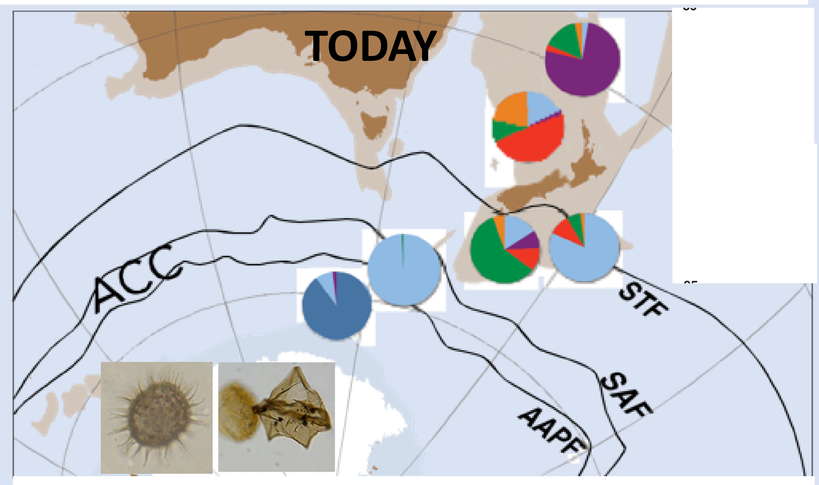
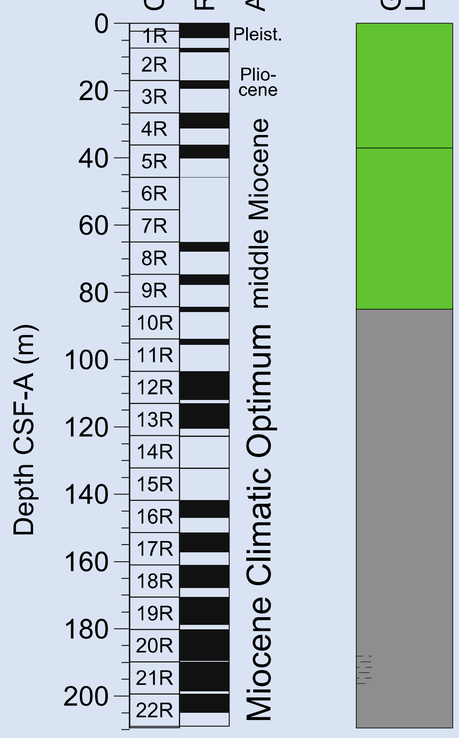


Figure 3: Present-day dinocyst assemblages across the Southern Ocean fronts [3]

Preliminary palynological results



High variability in the dinocyst assemblages at Site U1521 reflects variability in surface water features.
Three zones can be identified by differences in the palynological assemblages:

Zone A: high productivity and sea ice (different from today, ice sheet melting?)
Zone B: warm waters, reduced to absent sea ice
Zone C: high productivity, sea ice present (similar to today)

References: 1. McKay, R.M., De Santis, L., Kulhanek, D.K., and the Expedition 374 Scientists, 2018. Expedition 374 Preliminary Report: Ross Sea West Antarctic Ice Sheet History. International Ocean Discovery Program, 374. https://doi.org/10.14379/iodp.pr.374.2018; 2. Zachos et al. 2001, Science, 292, Issue 5517, pp. 686-693, DOI: 10.1126/science.1059412; Sangiorgi et al., 2018, Nature Communications, 9, Article number: 317; 4. Comiso, J. et al., 2001, *Journal of Geophysical Research 116*. 5. Petty, et al., 2014 *The Cryosphere*).