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Vegetation and climate from two Oligocene glacioeustatic sedimentary cycles (31 and 24 Ma) cored by the Cape Roberts Project, Victoria Land Basin, Antarctica

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Abstract

The Cape Roberts Project recovered over 1500 m of coastal glaciomarine sediments of Oligocene and Early Miocene age off the Ross Sea margin of Antarctica. The strata are characterised by cyclic repetition of facies in a glaciomarine setting, and are interpreted to be a record of glacial-interglacial episodes involving significant changes in eustatic sea level on Milankovitch frequencies. We have undertaken a detailed study of pollen and spores (miospores) from an Early Oligocene (31 Ma), and a Late Oligocene (24 Ma) cycle. Although miospores are sparse in the core, averaging only ~1 grain per gram of sediment processed, over 1200 Cenozoic miospores were recovered for this study.

Previous studies of miospores from Ross Sea sediments have encountered problems differentiating between reworked and in situ palynomorphs. Here, only samples containing a low relative abundance of an Eocene dinoflagellate cyst assemblage (the Transantarctic Flora) have been used to infer the contemporaneous Oligocene miospore flora.

The flora of the Early Oligocene cycle is dominated by three species of *Nothofagidites*, and four types of *Podocarpidites*. The assemblage from the Upper Oligocene cycle is also dominated by *Nothofagidites* and *Podocarpidites*, but with the addition of two distinctive taxa, an angiosperm pollen and a bryophyte spore. Notwithstanding these additions, there is a slight decrease in floral diversity between the two cycles.

While this study confirms that some floristic changes did occur between Early and Late Oligocene time on the Victoria Land coast, the present data suggest that the changes were not extensive. It is likely that the vegetation of both cycles was a low diversity scrub of low stature, consisting of mainly *Nothofagus*, podocarps, and bryophytes. Modern analogues suggest that this vegetation was growing in a climate significantly warmer (Mean Summer Monthly Temperature 4–12 °C) than is found on the present day Victoria Land (MSMT −5 °C), although colder that the temperate climate suggested by the diverse flora found in Ross Sea sediments of Eocene age.

Keywords: Antarctica; Oligocene; Miospores; Paleobotany; Paleoenvironment

1. Introduction

All that is known of the terrestrial vegetation that grew on the Victoria Land coast during the Oligocene is inferred from two fossil *Nothofagus* leaves (Hill, 1989;

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Cantrill, 2001), very sparse miospore (pollen and spore) assemblages recovered from the drillholes DSDP Site 270 (Kemp, 1975; Kemp and Barrett, 1975), MSSTS-1 (Truswell, 1986), CIROS-1 (Mildenhall, 1989), and CRP-1- 3 (Askin and Raine, 2000; Raine and Askin, 2001), and an equally sparse phytolith record from the CRP cores (Thorn, 2001). The final source of evidence is a handful of samples from glacial erratics at McMurdo Sound that have been dated variously as "?Oligocene" and "post Eocene" (Askin, 2000). An uniting theme of these studies is the presence of a low diversity, *Nothofagus*-dominated assemblage from Early Oligocene strata. Some authors have suggested that while vegetation was still present in the region by Late Oligocene time, the diversity was reduced still further, representing a vegetation of lower stature (Kemp, 1975; Askin and Raine, 2000).

In the present study, we contribute to the Oligocene miospore dataset for the Ross Sea region, with more samples obtained from the Cape Roberts Project cores. The Cape Roberts Project (CRP) drilled through the margin of the Victoria Land Basin in the austral summers of 1997–1999 (Figs. 1 and 2). Over 1500 m of coastal glaciomarine sediments between 34 and 17 Ma old were cored, with 97% recovery (Davey et al., 2001; Florindo et al., 2005). The marine palynomorphs that

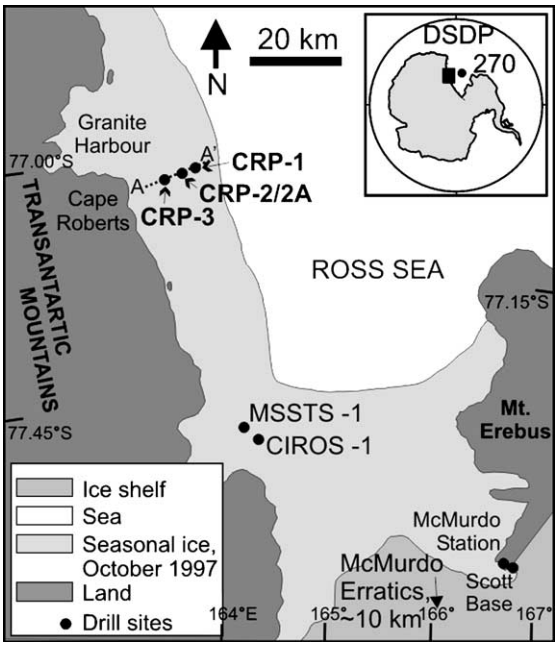

Fig. 1. Location map of the western Ross Sea region. The location of the three Cape Roberts Project core sites are shown, along with the CIROS-1 and MSSTS-1 core sites, and the McMurdo Glacial Erratics. Inset A is a map of Antarctica, which includes the location of DSDP Site 270 in the Ross Sea.

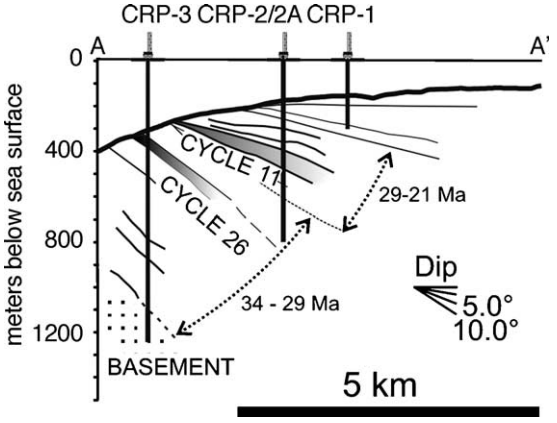

Fig. 2. An interpreted seismic section of the strata beneath the Cape Roberts Project drill sites, showing the stratigraphic relationship between the three drill holes, and the strata dipping offshore. The two intervals highlighted in gray, Cycles 26 and 11, are those that are sampled for palynology in this study.

were found in the same preparations are documented in Prebble et al. (this volume).

The strata are characterised by the cyclic repetition of facies in a glaciomarine setting seaward of the Transantarctic Mountains, which began rising ~55 million years ago (Fitzgerald, 1992). The 47 cycles are interpreted to be a record of glacial–interglacial episodes involving the advance and retreat of an ice margin over the drillsite, accompanied by significant (c. 50 m) changes in eustatic sea level (Naish et al., 2001a). Here, we report and interpret analyses of miospores from closely spaced samples through two of the 47 cycles at high resolution: Cycle 26, with an age of 31 Ma (Hannah et al., 2001a), and Cycle 11, with an age of 24.1 Ma (Wilson et al., 2000). The timescale used is that of Berggren et al. (1995). The nature of the Oligocene vegetation is then discussed, with reference to modern analogues.

1.1. Previous work on the Ross Sea Oligocene vegetation

All miospore assemblages recovered from Ross Sea strata of Oligocene age are dominated by *Nothofagidites* pollen. In DSDP 270, Kemp (1975) reported an assemblage dominated by both *fusca*-type and *brassii*-type *Nothofagidites*, and *Podocarpidites*, with minor components of Proteaceae and Myrtaceae. At the time, this assemblage was not thought significantly different to that found in the Eocene McMurdo Erratics (McIntyre and Wilson, 1966), and a low diversity *Nothofagus*-dominated vegetation of uncertain form and stature was inferred to have existed during the Oligocene.