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Preliminary Report on Early Oligocene and ?Latest Eocene Marine Palynomorphs from CRP-3 Drillhole, Victoria Land Basin, Antarctica

M.J. HANNAH[1]* J.H. WRENN[2] & G.J. WILSON[3]

[1]School of Earth Sciences, Victoria University of Wellington, PO Box 600, Wellington - New Zealand
[2]Department of Geology and Geophysics, Centre for Excellence in Palynology,
Louisiana State University, Baton Rouge, Louisiana 0803 - United States of America
[3]Institute of Geological and Nuclear Sciences Ltd, PO Box 30 - 368 Lower Hutt - New Zealand

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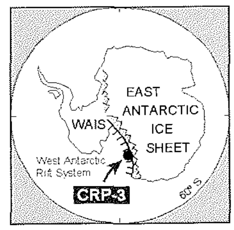


Abstract - Moderately diverse assemblages of marine palynomorphs have been recovered from the top section of the CRP-3 drillhole down to 162.11 meters below sea floor (mbsf). Diversity of the assemblages falls below this level. Below 324.39 mbsf most samples are either barren or have extremely low yields. Three distinct groups of marine palynomorphs were recognised: 1. Prasinophytes algae, predominantly *Cymatiosphaera*; 2. Acritarchs; 3. Dinoflagellate cysts comprising at least 26 species, several of which are undescribed. Reworked specimens of the Palaeogene Transantarctic Flora were recorded in CRP -3 are present, especially between 25.96 and 162.11 mbsf. Three marine palynomorph units are recognised based on the distribution of dinoflagellate cysts. Unit 1(7.72 to 87.47 mbsf) and Unit 2 (107.38 - 324.19 mbsf) are Early Oligocene in age. The oldest unit, Unit 3 (330.17 - 823 mbsf), is earliest Oligocene - ?latest Eocene in age.

INTRODUCTION

CRP -3 is the final drill hole of the Cape Roberts Project which planned to core and sample strata of Cenozoic age in the Victoria Land Basin, Antarctica. The project aimed to both document the early history of the current Antarctic ice sheet and develop an uplift history for the Transantarctic Mountains. The CRP -3 drillhole was situated about 12 km east of Cape Roberts in about 300 m of water. The first core was taken in early October 1999 and drilling was completed in mid November of the same year. The section was continuously cored to a depth 939.42 meters below sea floor (mbsf) with a core recovery of 97%. Three drillholes were positioned to ensure that the entire Cenozoic sequence of the Victoria Land Basin was sampled (Fig. 1). The bottom of the Cenozoic section was reached in CRP - 3 when Beacon Sandstone (Early Devonian), considered to be local basement, was encountered at 823 mbsf (Cape Roberts Science Team 2000).

Hannah et al. (this volume) assess the chronostratigraphic data available to date the Cenozoic sequence from CRP-3. The first appearance of two diatom species (Harwood & Bohaty, this volume) and five Strontium isotopic ages (Lavelle, this volume) indicate an early Oligocene (about 31 Ma) age for the strata between 3 and 190 mbsf. Below this level there very few constraints on the age of the core. The lack of any *in situ* cysts of dinoflagellates (dinocysts) attributable to the well known Transantarctic Flora (see below) suggests that the base of the hole may not be any older than earliest Oligocene /?late Eocene, between 33.7 and 35.2 Ma. Specimens of the Transantarctic Flora were not considered to be *in situ* because of their low numbers, sporadic distribution and often fragmentary preservation. The distribution of the Transantarctic Flora is further discussed in Hannah et al. (this volume).

Palaeomagnetic analysis has documented a magnetostratigraphy for most of the Cenozoic interval. Florindo et al. (this volume) suggest an age of about 33.5 to 34.8 Ma for the base of the Cenozoic section. This is based on a correlation of the magetostratigraphy with the magneto polarity time scale (MPTS) of Cande and Kent (1995). However, there are no firm chronostratigraphic datums below about 190 mbsf to guide the linkage with the MPTS. Given the lack of chronostratigraphic datums in the deeper parts of the drillhole, the age estimate for the bottom of the hole of between 33.5 and 35 MA suggested by Hannah et al. (this volume) seems reasonable.

A summary stratigraphic column for the drillhole is presented in figure 2. The sediments encountered in the hole are dominated by sandstones, with intervals

**Corresponding author* (michael.hannah@vuw.ac.nz)

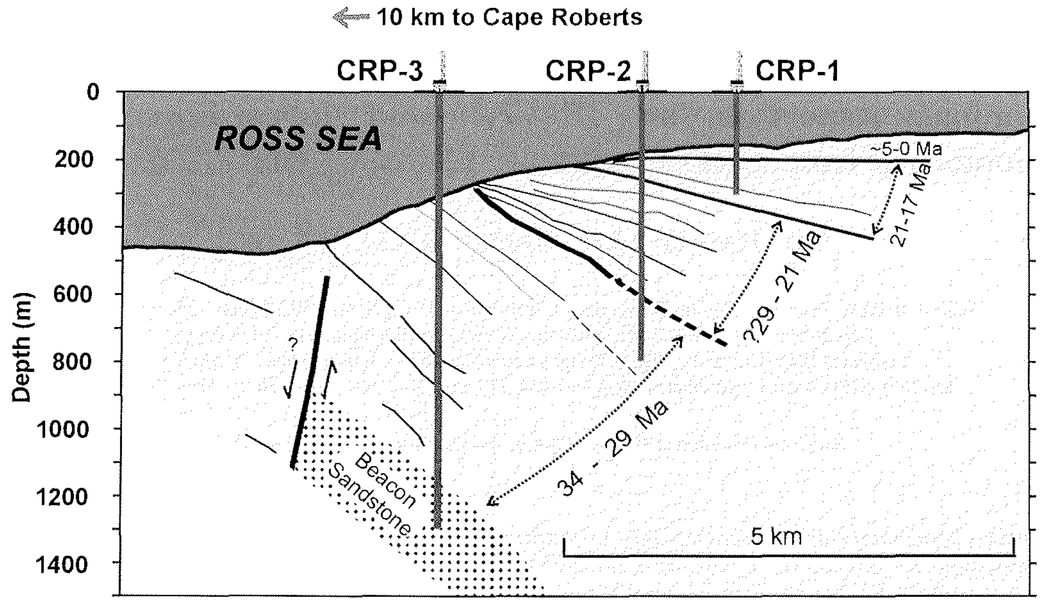


Fig. 1 - Interpreted seismic section showing the dipping sedimentary section off Cape Roberts. The positions of the three drillholes are shown (Cape Roberts Science Team 2000).

of diamictites and mudstones. These latter two lithologies are common down to about 350 mbsf, below which they decrease significantly leaving a very sandy section. All of the Cenozoic sediments show some evidence of glacial activity, although this also decreases significantly down section. Estimates of water depth are based largely on sedimentological evidence, which suggests that the Cenozoic sediments record a deepening from shallow deltaic at the base to inner shelf at the top of the hole.

Cycles of repeated facies divide the upper 480.27 meters of the drillhole into twenty three unconformity bound cycles of strata (Naish et al., this volume). Strontium dates imply that, at least down to 190 mbsf, very little time is unrecorded at the boundary of each cycle (Lavelle, this volume). Fielding et al., (2000) suggest that the cycles are a result of glacio-eustatic fluctuations. Below 480.27 mbsf repetitions of facies continue but no cycles could be confidently identified in the initial report on CRP-3.

PROCESSING TECHNIQUES

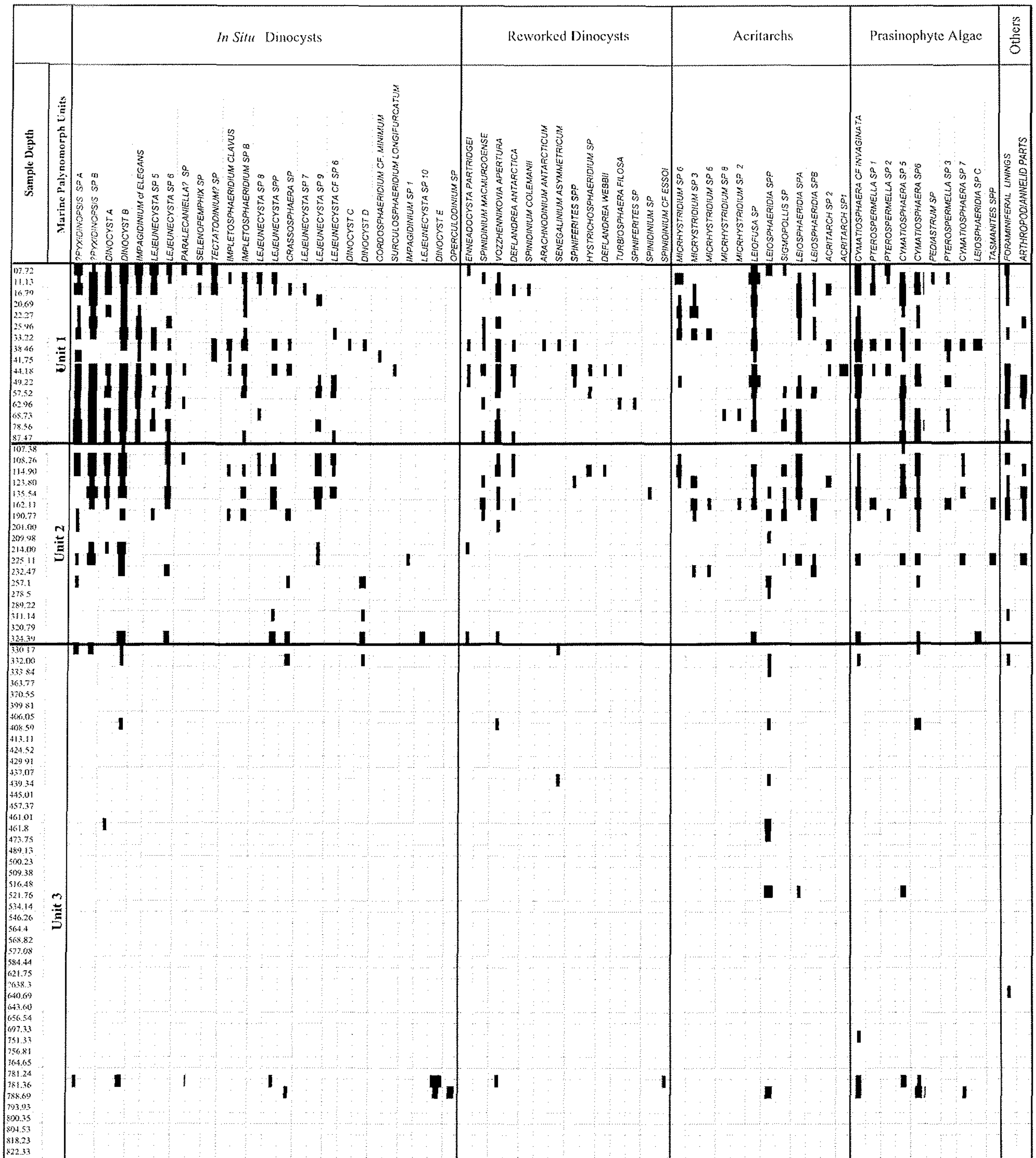
Eighty two samples were processed and examined for this study (Fig. 2). All were processed at the Crary Science and Engineering Centre, McMurdo station by J. Simes and B. Smith. In outline the processing stream consists of macerating about 5g of sample using 50% hydrofluoric acid in a Prolabo M-401 microwave digester. The microwave digester allowed very small amounts of chemicals to be used and all noxious fumes could be scrubbed prior to their being released into the Antarctic environment. A light oxidation of ten minutes in nitric acid was then applied and the residues were floated in sodium polytungstate at a specific gravity of 2.4. Finally, the float was sieved at 6 mm and the residue mounted in glycerine jelly. On examination, thin-walled palynomorphs such as leiospheres were commonly present on the slides indicating that the processing technique did not result in a loss of a significant number of palynomorphs. A detailed account of the processing system used for the Cape Roberts Drilling Project is given by Simes and Wrenn (1998).

OVERVIEW OF ASSEMBLAGES

A range chart listing all the marine palynomorphs species recovered from the drillhole is provided in table 1. The assemblage can be divided into three broad groups: 1. Dinoflagellate cysts (dinocysts) -both *in situ* and reworked; 2. phycoma of prasinophyte algae; 3. acritarchs. Most of the assemblages recovered are new and the informal open nomenclature developed in the initial report on CRP-3 (Cape Roberts Science Team, 2000) is maintained here. The leiospheres are herein retained within the acritarchs although their taxonomic position is still somewhat uncertain (Tyson 1995).

Between 7.72 and 162.11 mbsf most samples yielded well-preserved occasionally common *in situ* palynomorphs. Reworked dinocysts, predominantly *Vozzhennikovia apertura,* are also present in this interval. Foraminiferal linings are also common in many samples. Arthropod/Annelid fragments appear

Tab. 1 - Range Chart of marine palynomorphs recovered from CRP-3.



more sporadically. A significant downhole reduction in the both assemblage yield and diversity occurs at 190.77 mbsf. Between 190.77 and 334.39 mbsf the distribution of all types of palynomorphs becomes patchy.

A second sharp down-hole restriction in the floras occurs below 324.39. Here most samples examined are either barren or yield only very sparse assemblages. This situation continues to the bottom of the Cenozoic section. The sole exception to this are two samples at 781.24 and 788.69 mbsf, which contain a significant increase in both diversity and yield.

MARINE PALYNOMORPH UNITS

The *in situ* marine palynomorphs assemblages in CRP-3 can be subdivided into three informal units based primarily on distinctive species of dinocysts.

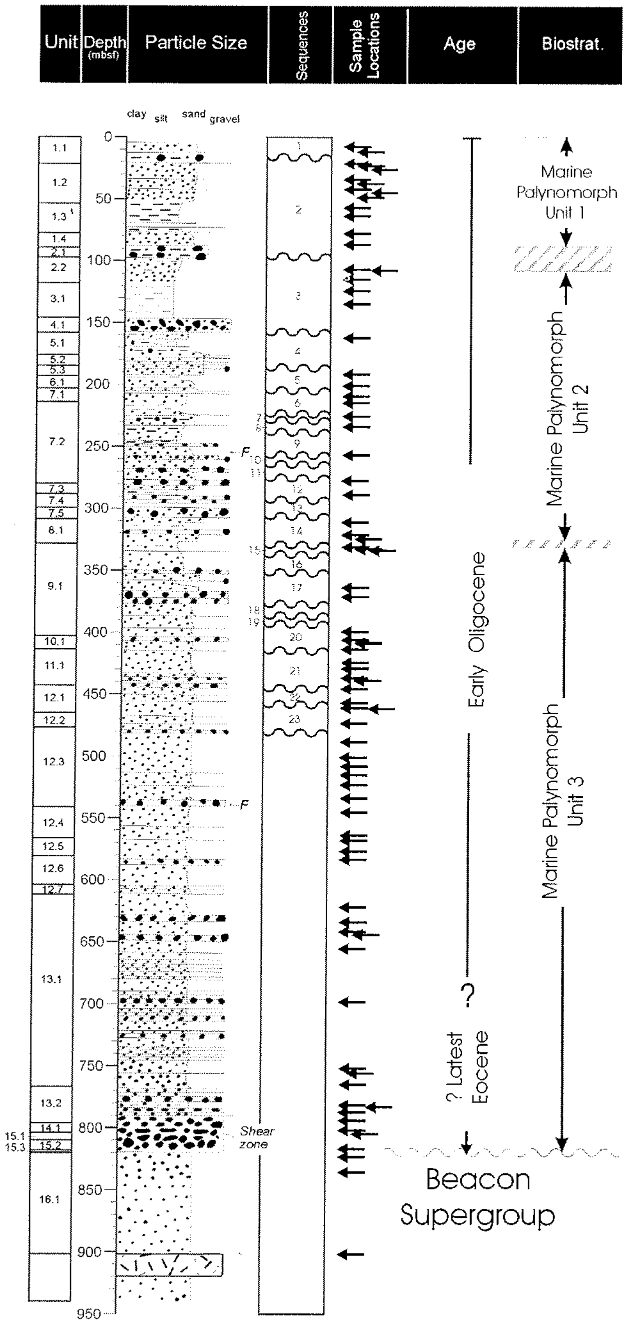


Fig. 2 - Stratigraphic column of CRP-3 (Cape Roberts Science Team 2000). Small arrows show the location of the palynomorph samples. Age from Hannah et al. (this volume); marine palynomorph units discussed in text.

MARINE PALYNOMORPH UNIT 3

Base of the Cenozoic section (823 mbsf) to about 330.17 mbsf - ?Latest Eocene / Early Oligocene

This is the thickest of the three marine palynomorph units representing over half of the Cenozoic section recorded in CRP-3. Its base is the top of the Beacon Sandstone and its top is placed at 330.17 mbsf, coincident with the top of the zone of very poor palynofloras. The top is marked biostratigraphically by the first appearance datums (FAD's) of the dinocyst *Lejeunecysta* sp. 6 and the fusiform acritarch *Leiofusa* although this latter species doesn't make a consistent appearance until 162.11 mbsf.

Most samples from this interval were either barren or yielded very poor assemblages. A spike in both diversity and yield, which is recorded in samples from 788.69 and 781.36 mbsf, is composed mainly of specimens of Dinocyst sp E although Pyxidinopsis sp A. Dinocyst B, and several species of *Cymatiosphaera* (prasinophyte algae) are also *in situ* components of this narrow interval. Single specimens of *Vozzhennikovia apertura* and *Spinidinium* cf *essoi* are also present, but these are probably reworked.

MARINE PALYNOLOGY UNIT 2

324.39 - 107.38 mbsf - Early Oligocene

The FAD of the dinocyst *Lejeunecysta* sp. 6 marks the base of this unit which extends up to the FAD of a large distinctive dinocyst, *Impagidinium* cf *elegans* (Hannah et al., 2000) A preservational change at 162.11 mbsf effectively divides this marine palynology unit into two parts. Depauperate palynomorph assemblages were recovered from the lower part of the unit (between 342.39 - 190.77 mbsf). However, in general, species that dominated the upper part of the unit are the most common forms in this interval.

In contrast assemblages from the upper part of the unit (162.11 to 107.38 mpsf) contain numerous palynomorphs and are moderately diverse. *Pyxidinopsis* species A and B, and Dinocysts A and B dominate the dinocysts. Several species of *Lejeunecysta* are also significant components of the dinocyst assemblages. Phycoma of *Cymatiosphaera* dominate the Prasinophyte group.

MARINE PALYNOLOGY UNIT 1

87.47 - 7.72 mbsf - Early Oligocene

This unit is bounded at its base by the FAD of the dinocyst *Impagidinium* cf *elegans* and continues to the top of the drillhole. This unit contains the richest, most diverse, assemblages in the core. The same four dinocyst species which dominate the upper part of Unit 2 (*Pyxidinopsis* spp A & B, Dinocyst A and Dinocyst B) continue to dominate in this unit. To this is added the distinctive form of *Impagidinium* cf *elegans*. Similarly, several species of *Lejeunecysta* are prominent components of the dinocyst assemblages.

The fusiform acritarch *Leiofusa* is the most prominent acritarch in this unit being recovered from almost every sample. Species of *Leiosphaeridia* are also common. Five species of *Micrhystridium* make this genus the most diverse group of acritarchs although, except for between 20.69 and 32.22 mbsf, they are rare. *Cymatiosphaera* spp. continue to dominate the Prasinophyte assemblage.

OTHER ANTARCTIC MARINE PALYNOMORPH OCCURENCES: THE CAPE ROBERTS ASSEMBLAGES IN CONTEXT

The assemblages recovered from the Cape Roberts cores assist considerably in filling the gap in the record between the modern Antarctic assemblages and the well known Transantarctic Flora of Eocene / Early Oligocene age.

Studies of modern dinocyst distribution around Antarctica are limited. Marret & de Vernal (1997) documented the dinocyst distribution on the ocean floor south of Australia. All samples used by Marret & de Vernal yielded assemblages that were both more diverse and richer than any found in the Cape Roberts Cores. A second study by Harland et al. (1998) described dinocysts from a transect from the Falkland trough through to the Weddel Sea. The diversity and yield of the assemblages recovered from samples taken north of 60°S were similar to the southern ocean assemblages documented by Marret & de Vernal (1997). Dinocyst numbers and diversity in sample from south of 60° are more comparable to, but generally less than, samples from the Cape Roberts cores. The dominant species from the Weddel Sea samples, *Selenopemphix antarctica* and several species of *Protoperidinium,* were not recorded in any samples from the Cape Roberts drillholes.

Palynomorphs were recovered from the Quaternary section of CRP -1 (Hannah et al., 1998, Wrenn et al., 1998) because of their fragmentary preservation and very sporadic distribution most of the dinocysts and acritarchs they were originally considered to be reworked from the underlying Miocene section. However, Wrenn et al. (1998) documented a limited flora of previously undescribed protoperidinioid dinocysts from a carbonate-rich unit between 31.89 and 33.82 mbsf and as a result suggested that other protoperidinioid cysts from the Quaternary interval may not be reworked.

The Cape Roberts Drilling Project drillholes offer an unprecedented record of the Miocene to ?Eocene High Latitude palynomorph floras. Hannah et al. (1998) documented and formally described the Miocene assemblages recovered from CRP-1. Previous records of Miocene palynomorphs from the Antarctic region are very limited. Truswell (1986) recorded reworked dinocysts and some possibly *in situ* prasinophytes from the Miocene section of MSSTS-1 drillhole. A dinocyst assemblage containing *Bitectatodinium tepikiense* has been reported from the Hobbs Glacier Formation of James Ross Island (Pirrie et al., 1997). The presence of *Bitectatodinium tepikiense* suggests an age of no older than Miocene for the assemblage. Moreover the overall age of the formation relies on the dating of the overlying James Ross Island Volcanic Group, which can be as young as 3Ma (Pirrie et al., 1997), so a Pliocene age for the assemblage cannot be ruled out. The CRP 2/2A and CRP-3 drillholes continue the palynomorph record down to at least the Early Oligocene and possibly the latest Eocene (Hannah et al., 2000, this study.)

Antarctic Palaeogene dinocyst assemblages are relatively well known and were originally recorded from erratics at Minna Bluff (Cranwell et al. 1960; Cranwell 1964) and Black Island (McIntyre & Wilson 1966), McMurdo Sound. They were described in more detail by Wilson (1967) and are now well documented from numerous southern high latitude sites (see, for example, Archangelsky, 1968, 1969; Haskell & Wilson, 1975; Kemp, 1975; Hall, 1977; Wrenn, 1981; Goodman & Ford, 1983; Wrenn & Hart, 1988; Wilson, 1989; Hannah, 1997; Levy & Harwood, 2000). Wrenn and Hart (1988) proposed the name Transantarctic Flora for this assemblage in recognition of its widespread distribution in Antarctic regions. However, its age range remains somewhat problematical. Hannah (1997) placed the top of the Transantarctic Flora in CIROS-1 in the earliest Oligocene (Chron C13 r) whereas Wilson et al. (1998) placed the same datum in the latest Eocene (Chron C15n) Unfortunately no unequivocally *in situ* examples of the Transantarctic Flora were recorded in any of the Cape Roberts drillholes to clarify the relationship between this widespread Palaeogene flora and the younger Cape Roberts assemblages.

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