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Chronology and Chronostratigraphy for CRP-2/2A

Introduction

In order to determine the driving forces of glacial fluctuations and the impact of Antarctic ice sheets on global climate, it is crucial to seek high-resolution records, with well-constrained chronologies, from the Antarctic continental margin. In particular, to test the influence of astronomical forcing of Antarctic glaciation, it is necessary to obtain chronological resolution of the order of tens of thousands of years. This is a demanding task on the Antarctic margin where frequent unconformities, lack of stratigraphically widespread cosmopolitan microfauna, and lack of datable volcanic or calcareous material normally conspire against construction of detailed chronostratigraphies. Indeed, it is difficult to develop a robust chronostratigraphy for parts of the CRP-2/2A record. However, due to the presence of material suitable for applying a wide range of stratigraphic dating techniques, the CRP-2/2A record contains an interval where the chronology is constrained to better than 100-kyr resolution. This is a first for Palaeogene and Neogene strata from the Antarctic margin and represents a significant step forward in solving some of the major goals of the Cape Roberts Project.

In this final section of the Scientific Report for CRP-2/2A, four papers are presented which, in conjunction with biostratigraphic data from the earlier "Palaeontological studies for CRP-2/2A" section, provide the data required for developing a chronostratigraphy for the CRP-2/2A drill hole. The first three papers in this section address strontium isotopic dating, $^{40}Ar/^{39}Ar$ geochronology, and magnetostratigraphy, while the final paper (Wilson, Bohaty et al.) represents a summary of all relevant age data and a widely agreed interpretation of the chronostratigraphy of the CRP-2/2A record (but see Lavelle).

Numerical ages for the CRP-2/2A sedimentary record are provided by two main techniques: $^{87}Sr/^{86}Sr$ ratios from shell fragments (Lavelle) and $^{40}Ar/^{39}Ar$ dating of volcanic tephra and clasts (McIntosh). Evidence from shell taphonomy provides important information about whether an $^{87}Sr/^{86}Sr$ age represents a depositional age or a maximum age due to reworking of the shell material. Similarly, pumice from three stratigraphic levels is considered *in situ* and therefore provides depositional $^{40}Ar/^{39}Ar$ ages, while volcanic clasts are assumed to have been reworked and provide maximum $^{40}Ar/^{39}Ar$ ages. Both of these techniques have provided important evidence concerning the age of strata recovered in CRP-2/2A.

The magnetostratigraphy for CRP-2/2A (Wilson, Florindo et al.) was developed after detailed stepwise demagnetization of more than 1000 samples. The sedimentary units generally have stable magnetizations that pass field tests for palaeomagnetic stability. However, palaeomagnetic polarity is a binary signal, and, in Antarctic margin settings where stratigraphic unconformities are frequent, reliable independent age constraints are required to enable correct age interpretation.

Results from $^{40}Ar/^{39}Ar$ and $^{87}Sr/^{86}Sr$ dating, combined microfossil biostratigraphy and magnetostratigraphy have been integrated by Wilson, Bohaty et al. to provide a best-fit chronostratigraphic interpretation for CRP-2/2A. The philosophy of the paper was to provide an age interpretation for the core, and, where no unique interpretation was evident, to clearly state alternative interpretations. It was not possible to provide a single age-depth correlation for large parts of the core. However, for the interval between 130 and 306 metres below sea floor (sequences 9, 10 and 11), the age model is sufficiently constrained to allow a chronology with better than 100-kyr resolution (although other interpretations are possible for Sequence 9). This is a considerable achievement, and, for the first time, enables investigation of Palaeogene Antarctic margin sediments in terms of astronomical forcing of climate.

It is important to note that the period of time being investigated by the Cape Roberts Project is currently under review. All of the dating constraints used by Wilson, Bohaty et al. are calibrated, with the exception of the $^{40}Ar/^{39}Ar$ dates, against the magnetic polarity time scale of Cande & Kent (1995). Recent studies indicate that the magnetic polarity time scale could be mis-calibrated by up to 0.85 million years in the vicinity of the Oligocene-Miocene boundary (Shackleton et al., 2000). Independent evidence for this mis-calibration is apparent in CRP-2/2A, where two high-precision $^{40}Ar/^{39}Ar$ dates fall within intervals with the “wrong” polarity. The numerical ages of the CRP-2/2A record could therefore require revision in the future. Despite possible future re-calibrations of the magnetic polarity time scale, the chronology of CRP-2/2A (Wilson, Bohaty et al.) should provide an excellent basis for testing the driving forces of Antarctic glacial fluctuations.

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