

# 行政院國家科學委員會補助專題研究計畫成果報告

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\* 西南太平洋古海洋學研究 (I): ODP1123 及 1125 號岩芯之鈣質 \*  
\* 微化石生物地層及有孔蟲氧碳同位素地層 \*  
\* Paleocceanography of the Southwest Pacific (I): Calcareous \*  
\* Biostratigraphy and Stable Isotope Stratigraphy of ODP 1123 & 1125 \*  
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計畫編號：NSC-89-2611-M-002-009-ODP

執行期間：88 年 08 月 01 日至 89 年 10 月 31 日

計畫主持人：魏國彥

執行單位：臺灣大學地質科學系

中華民國 90 年 2 月 21 日

西南太平洋古海洋學研究 (I): ODP1123 及 1125 號岩芯之鈣質超微化石生物地層及有孔蟲氧碳同位素地層

Paleoceanography of the Southwest Pacific (I): Calcareous Biostratigraphy and Stable Isotope Stratigraphy of ODP 1123 & 1125

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計畫參與人員：楊天南、陳俐陵、王谷神

## Introduction

One aim of ODP Leg 181 was to develop a detailed southern mid- to high latitude biochronology and magneto-chronology for the Oligocene through Pleistocene, for the oceanic realm between the Subantarctic Front and just north of the Subtropical Convergence, immediately east of New Zealand. The only existing Neogene site in this region, DSDP Leg 90, Site 594, located just south of the Subtropical Convergence on the Chatham Rise, provided a low-resolution late Neogene biozonation (Lohman, 1985). The ODP Leg 181 sites, strategically chosen on the Hikurangi Plateau, Chatham Rise, and Campbell Plateau to detail both the Cenozoic global climate change and the changing paleoceanographic regimes of this area, has proved very useful in expanding our knowledge of this region and its global significance. Because Leg 181 simultaneously develops magneto-stratigraphy, isotope stratigraphy and biostratigraphy, it can provide definitive links

to the standard time scale for the subantarctic and subtropical New Zealand zonal schemes of nannofossil and planktonic foraminiferal datums, i.e., ties to the conventional Cenozoic New Zealand Stages (Edwards et al., 1988). Leg 181 drilling of a latitudinal transect across the Subtropical Convergence provided us an opportunity to improve and refine existing biostratigraphic schemes, and assist in intercalibration of high- and mid-latitude zonations and species ranges in key microfossil groups for biochronology.

As indicated by many previous studies in this area of the southwest Pacific, the standard zonation schemes are not always applicable due to the paucity/absence of some of the index species. It has also been shown that several important Neogene nannofossil markers show substantial diachroneity across the latitudes between the equator and the warm subtropics (36° S) in the southwest Pacific west of New Zealand (Dowsett, 1988). Ranges of nannofossils at high-latitudes (50°- 65° S) in the South

Atlantic and Indian Oceans also show significant diachroneity (Wei et al., 1993). It is conceivable that the distribution /evolution/extinction of calcareous nannofossils in the studied areas have been modulated by the development of oceanic front systems, and therefore many of these datum levels are time transgressive. Magnetostratigraphies across the studied area has lead to better calibration of their numerical ages in various holes.

In this year's project, we not only examined nannofossils every three meters of ODP Site 1125, but also revisited the nanofossil biochronology of DSDP Site 594 at high resolution (every 1.5 meters per sample). Furthermore, we conducted oxygen and carbon isotopic analyses of two planktic and one benthic foraminiferal species for the middle Pliocene to Pleistocene (4 – 0 Ma). In addition oxygen and carbon isotopic profiles of bulk sediments of DSDP 1121 was also examined.

# **I. Late Pliocene-Pleistocene Calcareous Nannofossil Biostratigraphy of Transitional Sites of DSDP594 and ODP594 in the middle latitudes of Southwest Pacific**

In order to establish an adequate biochronological framework for the transitional mid-latitudes in the southwest Pacific, the calcareous nannofossils of Sites DSDP 594 and ODP 1125 were investigated. Both sites are furnished with low-quality magnetostratigraphy as an independent calibration aid. Standard smear slides were

made for all samples using Optical Adhesive as a mounting medium. Calcareous nannofossils were examined by means of light-polarized microscope at 1250X magnification. We followed taxonomic concepts summarized in Perch-Nielsen (1985).

Nannofossils are abundant and well-preserved throughout both sequences except for the lowermost portion of ODP 1125 where nannofossil assemblages show signs of dissolution and overgrowth. Most of the age markers are in the late Pliocene-Pleistocene section whereas the major part of the sequence belonging to the upper Miocene and lower Pliocene is poorly resolved.

Based upon correlation with other lower-latitude sites in the warm subtropical region (DSDP593, 590, and 588), the synchroniety and usefulness of eight commonly used nannofossil datum levels were evaluated. These bioevents are: (1) the first occurrence (FO) of *Emiliania huxleyi*, (2) the last occurrence (LO) of *Psuedoemiliania lacunosa*, (3) the LO of *Calcidiscus macintyreii*, (4) the FO of medium-sized *Gephyrocapsa* spp., (5) the LO of *Discoaster brouweri*, (6) the LO of *Discoaster surculus*, (7) the FO of *P. lacunosa* and (8) the LO of *Reticulofenestra pseudumbilica*. As a result, a mid-latitude, transitional nannofossil biozonation was established with an adequate correlation with the low-latitude biozones. Due to the paucity of some age-diagnostic species, the newly erected biozonation is less resolved than the conventional low-latitude biozonation, Nevertheless, these biozones are

useful for correlating sites in the warm and cool subtropics separated by the Subtropical Divergence.

## II. Oxygen isotope stratigraphy of late-middle Pliocene of ODP 1125, and paleoceanographic implication

Oxygen and carbon isotopic analyses of multiple planktic and benthic foraminiferal species were carried out for the late-middle Pliocene (2.0 - 4.0 Ma). The left- and right-coiled forms of planktic foraminifera *Globigerina bulloides* show similar  $\delta^{18}\text{O}$  values and exhibit a general enrichment trend of  $^{18}\text{O}$ . The enrichment takes place in the interval between 82 mbsf and 75 mbsf (approximately 3.6 - 3.3 Ma, based upon nanofossil biochronology), signifying a major period of surface-water cooling while the benthic foraminifera *Uvigerina peregrina* does not show any significant change in  $\delta^{18}\text{O}$ . A major decoupling between planktic and benthic  $\delta^{18}\text{O}$  values occurs from 50 mbsf and above, suggesting a cooling of the intermediate waters, and/or a major build up of ice sheet while the surface ocean even became slightly warmer.

The  $\delta^{18}\text{O}$  of *Globorotalia inflata* are slightly more positive than that of *G. bulloides* except for an interval between 75 and 50 mbsf in which values of the two species are overlapping. This suggests that the surface ocean was well mixed during this period (approximately 3.3 to 2.5 Ma), probably as a consequence of the middle-Pliocene cooling. The  $\delta^{18}\text{O}$  of *G. inflata* became heavier again since 2.5 Ma, being

consistent with the contention that the intermediate water masses became colder at the same time.

The  $\delta^{18}\text{O}$  profiles obtained from multiple benthic and planktic species appear to provide information on the history of water stratification. We suggest that during the Pliocene warm optimum before 3.6 Ma, the surface ocean was well stratified. Once the cooling began, the surface water became less stratified, probably due to a more rigorous mixing and upwelling condition during 3.3 to 2.5 Ma. The middle-Pliocene cooling of surface waters appears to predate the onset of the northern hemisphere glaciation (probably also accompanied with an expansion of the Antarctic ice sheets) and cooling of the Subantarctic Intermediate Water.  $\delta^{18}\text{O}$  values of *G. bulloides* and *G. inflata* separated from each other after 2.5 Ma, indicative of the resumption of stratification of surface waters again.

## III. Carbon and oxygen isotope records in bulk sediments from Site 1121B

(collaborated with Dr. H.-S. Mii)

To characterize the stable isotope records of ODP Leg 181, Site 1121B, we performed 60 isotopic analyses on bulk sediments between 33.2 mbsf and 133.5 mbsf (Early to Late Paleocene). The carbonate material of the bulk sediments analyzed is mainly composed of nanofossils.  $\delta^{13}\text{C}$  values range from 1.8‰ to 3.5‰ and  $\delta^{18}\text{O}$  values range from -1.6‰ to 1.5‰.

A 1‰ increase in average  $\delta^{13}\text{C}$  (from

2.0‰ to 3.0‰) values is observed in Early Paleocene. Average  $\delta^{13}\text{C}$  values then fluctuate between 2.3‰ and 3.4‰ with the average around 3‰ up section in Late Paleocene. Average  $\delta^{18}\text{O}$  values increase 2‰ (from -1.5‰ to 0.5‰), decrease 1‰, and then increase 0.6‰ in Early Paleocene. Average  $\delta^{18}\text{O}$  values vary between -0.1‰ and 1.1‰ (with the average about 0.4‰) for Late Paleocene. The Early Paleocene 2‰ increment in  $\delta^{18}\text{O}$  values, however, only corresponds to 0.6‰ positive shift in  $\delta^{13}\text{C}$  values.

Because the  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  values do not systematically vary with the carbonate content (between 0 and 60 wt.%; Leg 181 Initial Report), the partial dissolution effect

may be eliminated or reduced to the minimum. With limited age control (roughly from 63 to 56 Ma), our average  $\delta^{13}\text{C}$  values are comparable with those of bulk sediments reported in Corfield (1994: Earth Science Review, V. 37, p. 225-252). However, the overall pattern of  $\delta^{13}\text{C}$  curves does not exhibit the same trend. Our  $\delta^{18}\text{O}$  values are overall greater than those of the planktonic foraminifera but comparable to those of benthic foraminifera reported in Corfield (1994).

## Publications

Carter, R. M., McCave, I. N., Richter, C., Carter, L., .... **Wei, K.-Y.** ... (1999) Proc. Ocean Drilling Program, Initial Reports, 181 [CD-ROM] Available from: Ocean Drilling Program, Texas A&M University, College Station, TX 77845-9547, U.S.A.

魏國彥、陳俐陵、楊天南 (1999) 海洋鑽探計畫子計畫：國際海洋鑽探 181 航次之新第三紀鈣質超微化石生物地層研究。八十八年度海洋科學學門研究成果發表會，p112-124。