國際海洋鑽探 195 航次鈣質超微化石生物地層及南沖繩海槽 KS—1 岩芯之氧碳同位素地層研究

執行單位：國立臺灣大學 地質科學系
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本人於 2000 年 3 月向「國際海洋鑽探計畫」(Ocean Drilling Program, 簡稱 ODP)領銜提出一小型鑽探企畫書，提議在台灣東北海域、龜山島東方 75 公里處之南沖繩海槽進行鑽探，鑽入海床下方 420 公尺，取得長而連續的沈積物岩心三根，藉以研究第四紀黑潮的古海洋變化歷史。該鑽探企畫書通過層層審核，而被列入國際海洋鑽探 ODP195 航次之鑽探目標之一。本人以身爲該企畫書主要撰寫人之原因受邀參加該航次，並擔任該航次之微體古生物專家，與中國地質大學蘇新副教授共同負責航次所有鑽探站位之鈣質超微化石生物地層研究，建立沈積岩年代對比。

ODP195 航次於 2001 年 3 月 6 日由關島出發，橫越西太平洋，沿途完成三個站位（ODP1200, 1201 及 1202 站位），共鑽取 12 口岩心，於 5 月 3 日抵達台灣基隆港，結束全長 59 日之航次。

2001 年 8 月並回到德州農工大學對當時未及在船上剖析的岩芯進行檢視，補寫報告。航次報告已逾 2002 年出版，本人所撰寫之微體古生物學報告併入下列各章節。

Shipboard Scientific Party (2002) Leg 195 summary. *In* Salisbury, M.H., Shinohara, M., Richter, C., et al., *Proc. ODP, Init. Repts.,* 195, 1-63 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Shipboard Scientific Party (2002) Explanatory notes. *In* Salisbury, M.H., Shinohara, M., Richter, C., et al., *Proc. ODP, Init. Repts.,* 195, 1-56 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. (Responsible for the Biostratigraphy Section)

Shipboard Scientific Party (2002) Site 1200. *In* Salisbury, M.H., Shinohara, M., Richter, C., et al., *Proc. ODP, Init. Repts.,* 195, 1-173 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. (Responsible for the Biostratigraphy Section)

Shipboard Scientific Party (2002) Site 1201. *In* Salisbury, M.H., Shinohara, M., Richter, C., et al., *Proc. ODP, Init. Repts.,* 195, 1-233 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. (Responsible for the Biostratigraphy Section)

Shipboard Scientific Party (2002) Site 1202. *In* Salisbury, M.H., Shinohara, M., Richter, C., et al., *Proc. ODP, Init. Repts.,* 195, 1-46 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. (Responsible for the 1. Background and Objectives and 2. Biostratigraphy Section).

相關有關 ODP1202 站位之後續研究成果，整理如下：

Abstract

Calcareous nannofossil and planktic foraminiferal occurrence in the 410 meter long sequence drilled at ODP1202 suggest that the sedimentary record is younger than 127 kyrs. AMS C-14 dating of planktic foraminifers picked from 10 depth intervals in the upper 102 meter of ODP1202B forms the main basis for a chronologicalframework. The average sedimentation rate for the topmost 100 meters is 4.2 m/kyrs. An extrapolation of the sedimentation rate down to 225 mbsf yields an age of 50 ka. The sediments in the interval of ~230 – 280 mbsf are apparently of turbidite origin.

C/N ratio and $CaCO_3$ content of the bulk sediments in the <63 μ fraction suggest that the site did not reach to today's hemi-pelagic condition until 10 ka. Oxygen isotope profile indicates that superimposed on the global deglaciation trend, there was a continuous warming/freshening trend from 17 ka up to 8 ka. The late Holocene might have witnessed a flood spike at about ~4650 yrBP, and a cold spell at about 4245 yrBP.

Key Words: age model, oxygen isotopes, carbon isotopes, Okinawa Trough, Quaternary

I. Introduction

Being the primary proponent of Site ODP1202 (a.k.a KS-1) in the Southern Okinawa Trough, I was invited as a nannofossil expert to join the ODP Leg 195 during March – May, 2001. Besides serving as a microfossil biostratigrapher onboard of JOIDES Resolution, I acted as also the major coordinator for drilling and research of Site1202.

With the cooperation of Dr. Xin Su （蘇新）, calcareous nannofossil biostratigraphy was established primarily for ODP Site 1201D. Moderately to poorly preserved nannofossils in the middle sequence between 54 and 462 mbsf allowed us to recognize six nannofossil biozones. This thick turbiditic sequence represents an expanded record of late Eocene – early Oligocene age consisting of the top of

NP19/20, the NP21, NP22, NP23 and a truncated NP24. Both calcareous nannofossils and planktic foraminifera of Holes 1200 and 1202 were examined and reported. The results were published in the Biostratigrapy Section of individual chapters summarizing the on-board study of sites drilled during Leg 195 (see the attached list in the end).

On-shore laboratory investigation has been devoted to carbon-14 dating, oxygen and carbon isotope analyses of planktic foraminifera and supplementary geochemical studies of bulk sediments of Hole ODP1202B and 1202D. The main thrust is to establish a chronological framework for Site 1202. Various lines of data also lead us to draw a preliminary scenario of paleoceanogrpahic changes at the southern end of the Okinawa Trough during the past 25 kyrs. Because the funds provided by the NSC have been mainly employed for on-shore laboratory study, this extended abstract reports primarily the research results of ODP1202.

II. Material and Methods

Site 1202 was designed to obtain a high-resolution record of paleoceanographic changes of the Kuroshio during the late Quaternary from the southern slope of the southernmost Okinawa Trough. A total of four holes were drilled from a water depth of 1274 m at 24°48', 122 ° 30'N. Samples were obtained from the ODP Repository every 1.5 m from Hole 1202B (0.5 – 142 mbsf) and 1202D (143.9 – 407.0 m).

AMS C-14 Dating

More than 300 specimens of surface-water dwelling planktic foraminfera, including *Globigerinoides* spp. *Orbulina universa*, were picked exhaustively from the >250μ size fraction of 10 selected intervals where foraminifera are barely sufficient enough. CO_2 gas was yielded from the picked specimens and sent to the Rafter Radiocarbon Laboratory, Institute of Geological and Nuclear Sciences, New Zealand for AMS dating. The reported ages were converted to "calendar ages" using CALIB rev 4.3 Program. In the conversion, we adopted a $\Delta R = 35 \pm 25$ years (the local difference in reservoir age from 400 years in the southern Okinawa Trough) as determined from annually banded corals of Ishigaki Island (Hideshima et al., 2001). The calibrated ages were then converted into thousand years BP (ka before AD1950).

Isotope Analyses of Planktic Foraminifera

Specimens of planktic foraminifera *Neogloboquadrina dutertrei* in the 355~425μ size fraction were picked from sieved sediments. Cleaned specimens were reacted with phosphoric acid at 90°C in the heating block of the Micromass MultiCarb automation system. The CO_2 gas generated was analyzed using a Micromass IsoPrime isotope ratio mass spectrometer housed in the Department of Earth Sciences, National Taiwan Normal University. The carbonate standard NBS-19 was used to calibrate to

the Peedee belemnite (PDB) standard. The average precision of the NBS standard analyzed was 0.03‰ for $\delta^{13}C$ and 0.08‰ for $\delta^{18}O$ (N=113).

Geochemical Analyses of Bulk Sediments

Total carbon, total organic carbon, and total nitrogen in weight percentage (% wt) of the bulk sediments in the <63μ fraction were measured. The $\delta^{13}C$ of organic carbon in the <63μ fraction of bulk sediments was also determined using the Finnigan MAT $Delta^{plus}$ mass spectrometer at the Institute of Geosciences, National Taiwan University.

III. Results and Discussion

Despite its deep penetration of Site 1202, the 410 meters of sedimentary sequence drilled may only record the very last of the Quaternary – the last 100 kyrs. The age-diagnostic marker for nannofossil Zone NN21, *Emilainaia huxleyi*, occurs persistently throughout the sequence, suggesting that the drilled sequence is younger than 0.26 Ma. The absence of pink *Globigerinoides ruber*, on the other hand, delimits the sequence to be even younger than 127 kyrs (Lee et al., 1999; Wei et al., 2000). The persistent appearance of orange-colored tiny *Zeaglobigerina rubescens* indicates that the sediments recovered are young and fresh (Parker and Berger, 1971).

The AMS C-14 dating of planktic foraminifers picked from 10 intervals down to 102 mbsf allows constructing an adequate chronological framework for the last 24 kyrs. The average sedimentation rate of the topmost 100 meters of the record is about 4.23 m/kyrs. The interval from 230 ~ 280 mbsf is of poor recovery, and the recovered sediments are sandy, marked by high percentage of coarse sediments (>63μ). This ~50 m interval is apparently a turbidite dominated interval. The truncation of this interval by turbidites makes it impossible to construct a continuous record. Oxygen isotope profile together with C-14 dating pinpoints the interval of ~ 85 – 87 mbsf to be the deposits of the last glacial maximum (LGM at about 20 ka). Extrapolation of sedimentation rate to ~225 m gives an age of 50 ka.

Detailed analyses of bulk sediments in the <63μ fraction suggest that the organic matters are dominantly marine origin for the past 10 kyrs (Holocene). In contrast, terrestrial source contributed significantly during the period of 25 ka to 11 ka.

The depletion of heavy oxygen isotope began at about 17 ka, and persisted until 8 ka, suggesting that superimposed on the global deglaciation trend, there exists a local freshening or warming up trend of seawaters. A reversal of $\delta^{18}O$ to heavy values suggests a local registration of the Younger Dryas at 11.6 –11.1 ka. A fresh-water spike was signaled at ~4650 yrBP., which was then followed by a cold spell at about

4245 yrBP.

References

Hideshima, S., Matsumoto, E., Abe, O. and Kitagawa, H. 2001. Northwest Pacific marine reservoir correction estimated from annually banded coral from Ishigaki Island, southern Japan. Radiocabon, 43(2A): 473-476.

Lee, M.-Y., Wei, K.-Y. and Chen, Y.-G. 1999. High resolution isotope stratigraphy for the last 150,000 years in the southern South China Sea: Core MD972151. Terrestrial, Atmospheric Oceanic Sci., 10: 239-254.

Parker, F. L., and Berger, W. H. 1971. Faunal and solution pattern of planktonic foraminifera in surface sediments of the South Pacific. Deep-Sea Res., 18: 73-107.

Wei, K.-Y., Chiu, T.-C. and Chen, Y.-G. 2000. Planktic foraminiferal oxygen isotope record of the last 350 thousand years of Core MD972142, southeastern South China Sea: Chronostratigraphy, orbital forcing and paleoceanographic implications. Jour. Geological Society of China, 43(3): 393-408.