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The Holocene *Pulleniatina* Minimum Event revisited: Geochemical and faunal evidence from the Okinawa Trough and upper reaches of the Kuroshio current

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Abstract

The Holocene *Pulleniatina* Minimum Event (PME) is characterized by a very low abundance of the planktonic foraminifer *Pulleniatina obliquiloculata* between ~4.5 and 3 ka. The PME occurs widely in the Okinawa Trough and the South China Sea, and can be correlated throughout this area; it has been related to variability in the Kuroshio current. To further explore the nature of the PME, we studied cores obtained from the southern Okinawa Trough and the upper reaches of the Kuroshio current. Faunal census data indicate that all cores record the PME between ~4.5 and ~3 ka. The relative abundance of *Neogloboquadrina dutertrei* is negatively correlated to that of *P. obliquiloculata* in the southern Okinawa Trough, but not in the sites at the upper reaches. Mg/Ca and $\delta^{18}O$ measurements on *Globigerinoides ruber* shells from the southern Okinawa Trough indicate that there was no change in sea surface temperature or sea surface salinity during the PME. The vertical structure of the water column as reconstructed by multispecies $\delta^{18}O$ and $\delta^{13}C$ profiles shows no consistent anomalies in the southern Okinawa Trough and western Philippine Sea during the PME. These observations suggest that: (1) the PME was not restricted to marginal seas, but widespread in the western North Pacific. (2) The high abundance of *N. dutertrei* during the PME in the Okinawa Trough may be a result of higher food-availability in the absence of *P. obliquiloculata*. (3) No distinctive, consistent anomalies in the paleoceanographic proxies are associated with the PME, implying there were no changes in hydrography and productivity. The absence of a linkage between faunal variation and paleoceanographic proxies indicates that we do not yet understand what causes changes in planktonic foraminiferal assemblages. This lack of understanding implies that we cannot always trust fauna-based paleothermometry at millennial timescales.

Keywords: *Pulleniatina* minimum event; Kuroshio; Holocene; Western North Pacific; Mg/Ca ratio; thermocline hydrography

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1. Introduction

During the past decade, paleoceanographers have documented an event called the '*Pulleniatina* Minimum Event (PME)', occurring between ~4.5 and 3 ka in deep-sea cores from the western North Pacific. The PME is characterized by minimum abundance of the planktonic foraminifer *Pulleniatina obliquiloculata.* The event generally lasted for at least 1000 years. The PME was recorded in several high-resolution cores located under the influence of the Kuroshio in the Okinawa Trough (Li et al., 1997; Jian et al., 2000; Ujiié and Ujiié, 1999; Ujiié et al., 2003a; Ijiri et al., 2005), the South China Sea (Jian et al., 1996; Pflaumann and Jian, 1999; Wang et al., 1999; Yu et al., 2000; Huang et al., 2002; Liu, 2004) and off the eastern coast of Taiwan (Shieh, 1993), whereas at least one core to the east of the Ryukyu Islands does not record the event (Fig. 1). The PME can be correlated over a wide area, and its significance has become an important issue in the Holocene paleoceanography of the western North Pacific. Some authors proposed that *P. obliquiloculata*, a species with its highest abundance in the equatorial current system in the Pacific Ocean (Bé, 1977; Pflaumann and Jian, 1999) (Fig. 2), serves as an indicator of the pathway of the Kuroshio. The marked reduction of *P. obliquiloculata* therefore was said to reflect a weakening or diversion of that current (Li et al.,

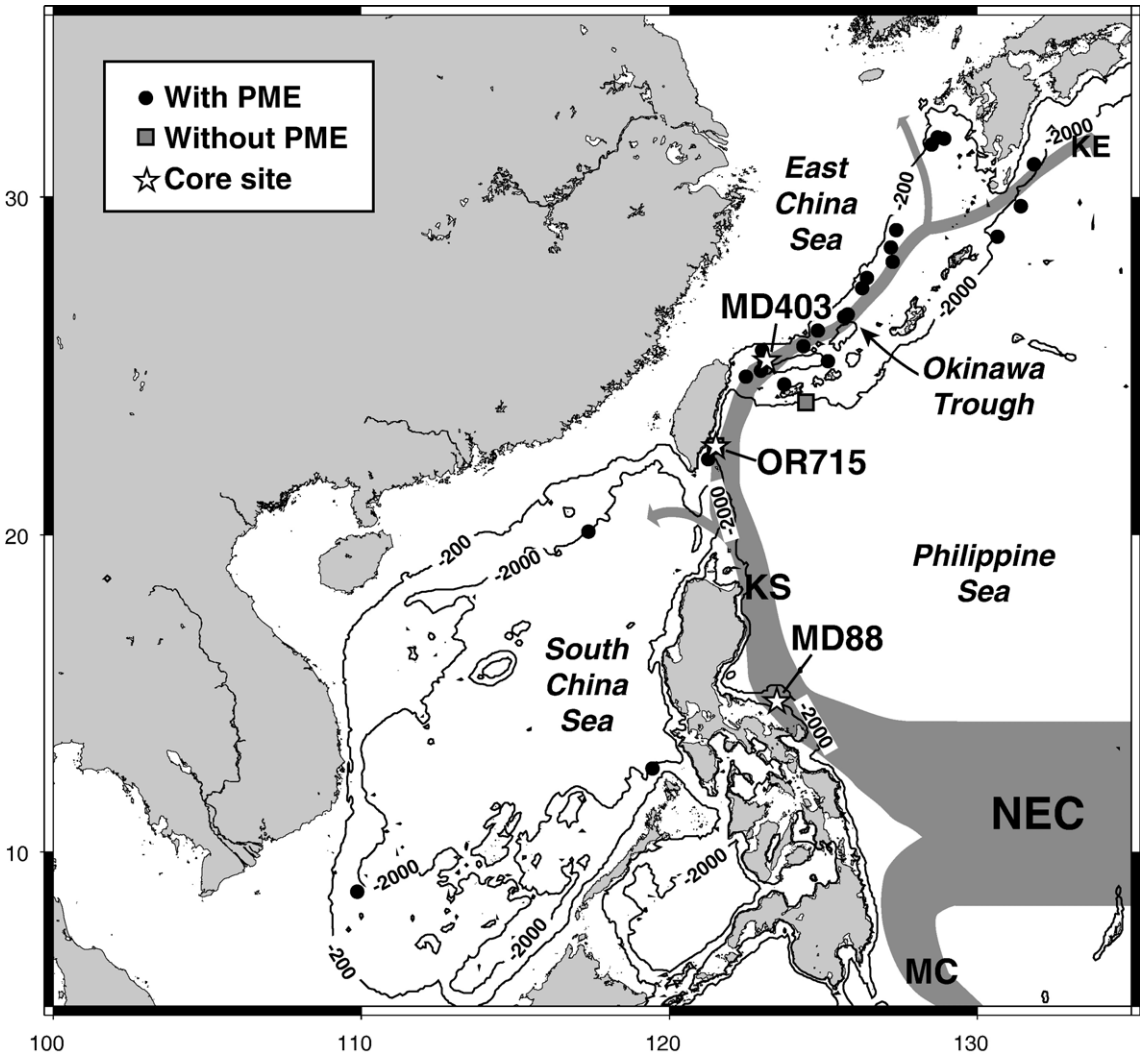

Fig. 1. Occurrence of the PME and the oceanographic settings of the study area. The North Equatorial Current bifurcates into the Kuroshio and the Mindanao Current. Faunal records are from Shieh (1993); Jian et al. (1996, 2000); Li et al. (1997, 2001); Pflaumann and Jian (1999); Ujiié and Ujiié (1999); Yu et al. (2000); Huang et al. (2002); Ujiié et al. (2003a); Liu (2004); Ijiri et al. (2005); Yuan-Pin Chang (personal communication). NEC: North Equatorial Current; KS: Kuroshio; MC: Mindanao Current; KE: Kuroshio Extension.