A multi-proxy study of planktonic foraminifera to identify past millennial-scale climate variability in the East Asian Monsoon and the Western Pacific Warm Pool

by

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ABSTRACT

High resolution paleo-climatological data from IMAGES core MD97-2141 (8.80° N, 121.31° E) located in the Sulu Sea within the western tropical Pacific reveal the first evidence of continuous millennial-scale variability in surface ocean conditions over the last 150,000 years. The millennial-scale planktonic foraminiferal oxygen isotope ($\delta^{18}O$) oscillations of *Globigerinoides ruber* (*G. ruber*) between 30,000-65,000 years (MIS3) are apparently in-phase with the Greenland ice core record and have amplitudes 1/3 to 2/3 the size of the Sulu Sea glacial-interglacial $\delta^{18}O$ amplitude of 1.3 ‰. In the same interval variations in planktonic foraminiferal Mg/Ca suggest that millennial-scale sea surface temperature (SST) variations were small (0.6-1°C) and out-of-phase with $\delta^{18}O$ indicating that $\delta^{18}O$ variability was mainly driven by changes in surface water salinity. This result implies that the linked East Asian monsoon and the western Pacific Intertropical Convergence Zones, both influencing the Sulu Sea, have fluctuated on the same millennial time scale as higher latitude climatic systems.

To further investigate the origin of the MIS3 $\delta^{18}O_{G.ruber}$ variations, the relative abundance of all planktonic foraminifer species and the $\delta^{18}O$ values of four planktonic foraminifer species was determined during MIS3. Combined, these data provide a detailed reconstruction of changes in the western tropical Pacific thermocline structure. The $\delta^{18}O$ composition of the mixed-layer foraminifera (*G. ruber* and *Globigerinoides sacculifer*) and upper thermocline species (*Neogloboquadrina dutertrei*) displays poor similarity with the $\delta^{18}O$ of the sub-thermocline dweller *Globorotalia crassaformis*. $\delta^{18}O_{G.crassaformis}$ shows larger $\delta^{18}O$ variations (~1 ‰) than the surface dwellers indicating past fluctuations in the influence of high salinity North Pacific Tropical Waters that currently enter the Sulu Sea across the Mindoro Strait during the months of the winter monsoon. The faunal and isotopic data suggest a switch from winter to summer monsoon predominance after 55 kyr. However this predominance is interrupted by at least three episodes of increased winter monsoon between 42-46 kyr.

Comparison of the proxy SST and planktonic foraminiferal $\delta^{18}O$ profiles for the last glacial/interglacial sequence from fourteen cores in tropical and subtropical oceanic settings indicates that termination I in $\delta^{18}O$ coincides with SST change at some sites, while $\delta^{18}O$ lags SST by 3,000 years at other locations. A comparison of SST and $\delta^{18}O$ shows a linear increase in SST from glacial to interglacial conditions. Sites where SST is leading the $\delta^{18}O$ record indicate fresher conditions during the LGM, and these sites are all located in areas influenced by increased atmospheric water vapor during times of today's La Niña.

DEDICATION

To my parents and my brother Tim

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