

Implications for paleo-reconstruction based upon oxygen isotopic ratio of different sized polar planktonic foraminifera

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Planktonic foraminifera provide a record of the ocean surface environment through the isotopic and chemical composition of their calcite shells. Shell oxygen isotopic composition ($d^{18}O$) is commonly used to reconstruct the paleo-environment, including temperature, salinity, and water column structure. *Neogloboquadrina pachyderma* is a common polar-subpolar planktonic foraminifer, thus it is an important species for the reconstruction of paleo-oceanography in the high latitude. Foraminifera in sediment trap samples are particularly useful for examining changes in ($d^{18}O$) over time, and for determining which seasons and depths are most represented. In the study, we examined seasonal variation in $d^{18}O$ of different sized *N. pachyderma* (sin.) using sediment trap samples collected over 3.5 years in the northwestern North Pacific Ocean. Shell $d^{18}O$ of small (125-180 μm) and large (180-250 μm) *N. pachyderma* (sin.) exhibited similar seasonal variation, with minimum values during September-October and maximum values during April-May. In the study, vital offset values were approximately -1 permil for both size classes throughout the study, except during 2000 (-0.8 permil). However, in the reconstruction of paleo-temperature, offset values should be examined from viewpoints of the equation used as oxygen isotope-temperature relationship and the presence of genotypes. $d^{18}O$ differences between size classes of *N. pachyderma* (sin.) in the present study varied seasonally, not a consistent offset; suggesting that the differences were due mainly to oceanographic conditions in the water column rather than to size-specific kinetic/metabolic effects. During summer, when the water column is stratified, large and small individuals appeared to mainly calcify near the pycnocline, at 25-35 m and approximately 45 m, respectively. During winter, when the water column is not stratified or only weakly stratified, both size classes calcified at or slightly above the pycnocline, at 45-65 m. Because the seasonal peaks in flux coincide with minimum and maximum water temperatures and contribution of the flux peaks is approximately equal, flux-weighted values of all (125-250 μm) and small (125-180 μm) shell size are in good agreement with the mean annual values (no flux-weighted) of small (125-180 μm) individuals. Thus, the fossil $d^{18}O$ data of *N. pachyderma* (sin.) most likely record the annual mean oceanographic environment around pycnocline depth, and size-specific differences in $d^{18}O$ reflect water column stratification.

Keywords: planktonic foraminifer, oxygen isotope ratio, *Neogloboquadrina pachyderma*, sediment trap, northwestern North Pacific