

Quaternary archaeal ammonia oxidation and associated nitrogen cycles in the South China Sea

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Euphotic zone nitrification (EZN) mediated by *Thaumarchaeota*, specific to ammonia oxidation, is a crucial process for marine carbon and nitrogen cycle. However, little is known about the EZN history during the Quaternary. Here, downcore records of isoprenoid glycerol dialkyl glycerol tetraethers (GDGTs), biomarkers of *Thaumarchaeota*, were used to infer variations of EZN in the South China Sea for the last two glacial cycles. The ratio of compound GDGT-2 to GDGT-3 showed a clear glacial-interglacial pattern, with higher values during the glacials and lower values during the interglacials. This pattern indicated enhancements of shallow cluster of *Thaumarchaeota*, which appeared to be more active to oxidize ammonia than the deep cluster, and thereby intensified EZN in the interglacials, and an opposite in the glacials. Interestingly, the inferred thaumarchaeal community shifts varied in parallel with the record of nitrogen isotope ratio of sedimentary organic matter ($\delta^{15}\text{N}_{\text{org}}$), showing lower values in the interglacials and higher values in the glacials, which has conventionally been interpreted as results of interglacial augments of N_2 fixation. We surmised here that in addition to N_2 fixation, EZN could have played an important role in controlling euphotic zone nitrate $\delta^{15}\text{N}$ likely by producing and degassing isotopically heavier N_2O . During the interglacials intensified N_2 fixation/nitrification may imply enhanced euphotic recycling of photosynthetic organic matter and resultant low efficiency of biological pump, as also indicated by increases of haptophyte relative to diatoms inferred from phytoplankton biomarker ratios in sediments.