

# Quantifying archaeal community autotrophy in the mesopelagic ocean using natural radiocarbon

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An ammonia-oxidizing, carbon-fixing archaeon, *Candidatus* “*Nitrosopumilus maritimus*,” recently was isolated from a salt-water aquarium, definitively confirming that chemoautotrophy exists among the marine archaea. However, in other incubation studies, pelagic archaea also were capable of using organic carbon. It has remained unknown what fraction of the total marine archaeal community is autotrophic *in situ*. If archaea live primarily as autotrophs in the natural environment, a large ammonia-oxidizing population would play a significant role in marine nitrification. Here we use the natural distribution of radiocarbon in archaeal membrane lipids to quantify the bulk carbon metabolism of archaea at two depths in the subtropical North Pacific gyre. Our compound-specific radiocarbon data show that the archaea in surface waters incorporate modern carbon into their membrane lipids, and archaea at 670m incorporate carbon that is slightly more isotopically enriched than inorganic carbon at the same depth. An isotopic mass balance model shows that the dominant metabolism at depth indeed is autotrophy (83%), whereas heterotrophic consumption of modern organic carbon accounts for the remainder of archaeal biomass. These results reflect the *in situ* production of the total community that produces tetraether lipids and are not subject to biases associated with incubation and/or culture experiments. The data suggest either that the marine archaeal community includes both autotrophs and heterotrophs or is a single population with a uniformly mixotrophic metabolism. The metabolic and phylogenetic diversity of the marine archaea warrants further exploration; these organisms may play a major role in the marine cycles of nitrogen and carbon.

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