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Influence of organic matter preservation on radiocarbon ages of marine organic biomarkers

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In some sedimentary environments, radiocarbon dating of marine organic matter is an important tool for the development of sediment chronologies. In recent times, radiocarbon dating of these sediments can be performed on individual organic compounds known to derive from marine primary producers. However, the reliability of paleoenvironmental reconstructions from organic biomarker compounds is strongly dependent on their preservation in the sedimentary record. Selective degradation of more labile organic compounds may bias proxy data that are based on ratios of different organic molecules in marine sediment cores such as the sea surface temperature estimates derived from alkenones and from tetraether lipids. One of the strongest influences on organic matter degradation is its exposure to oxygen during transport and subsequent deposition in the sediment.

The Black Sea shows a stable two-layer stratification with permanent anoxia in the deep basin and thus is an ideal location for our investigation of selective degradation/preservation of marine phytoplankton-derived and terrestrial lipid biomarkers. We analyzed the abundance of several lipid biomarkers and their ^{14}C concentration as well as bulk organic matter ^{14}C values in surface sediments on slope transects running from the oxygenated to the anoxic zone in the NW and NE part of the Black Sea. Bulk organic matter showed variable $\Delta^{14}C$ concentrations in surface sediments retrieved from 90 to 2000 m water depth with post-1950 values between 35 to 45 ‰ at two anoxic locations and values between -31 to -135 ‰ at other oxic and anoxic sites. ^{14}C values increased from oxic and sub-oxic to anoxic locations on different slope transects. At most locations investigated, phytoplankton-derived biomarkers (alkenones, C_{16} n-alkanoic acid) contained bomb-radiocarbon and were substantially ^{14}C-enriched compared to long-chain n-alkanoic acids (C_{26}, C_{28}, and C_{30}) as indicators for terrestrial input and bulk organic matter. ^{14}C differences between alkenones and terrestrial n-alkanoic acids were more pronounced in the anoxic settings compared to values measured in the oxygenated zone. This is interpreted to reflect better preservation of the marine biomarkers under anoxic conditions. We will also present compound-specific^{14}C results of crenarcheol and caldarcheol derived from marine archaeal communities.

Our data illustrate the large range of radiocarbon ages of marine and terrigenous organic matter preserved in marine sediments. Processes affecting the radiocarbon age of marine organic biomarkers in sediments include degradation coupled with redistribution and lateral transport and need to be considered when using radiocarbon dating on organic materials. Furthermore our results illustrate that biomarker-based proxy records may be biased by these processes.