Age relationships between lipid biomarkers in oxic and anoxic Black Sea sediments

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In sediments lacking macrofossils, sediment chronologies are often developed by radiocarbon dating of bulk sedimentary organic matter which is a complex mixture composed of young and old organic compounds of terrigenous and marine origin. In recent times, this can be circumvented by compound-specific radiocarbon analysis of individual organic molecules known to derive from specific sources, e.g. from marine primary producers. The reliability of the sediment chronologies based on organic biomarker compounds, however, is dependent on the preservation of the molecules in the sedimentary record. One of the strongest influences on organic matter preservation is its exposure to oxygen during deposition and within the sediment. As a consequence, results for locations with different bottom-water oxygen concentrations may be biased by extensive and selective degradation of certain compounds. We analyzed the abundance of several lipid biomarkers derived from marine and terrestrial primary production including alkenones, chrenarcheol and n-alkanoic acids and their radiocarbon concentration as well as bulk organic matter radiocarbon values in surface sediments. Sediment cores were taken on slope transects running from the oxygenated to the anoxic zone in the NW and NE part of the Black Sea. Conventional radiocarbon ages of bulk organic matter in core top sediments from 90 to 2000 m water depth varied between modern (post-1950) to 1000 years. Compound-specific radiocarbon ages of alkenones and crenarcheol, which are both known to derive from planktic sources, agree remarkably well at all locations irrespective of the oxygen content of the bottom water. Short-chain n-fatty acids were also found to generally agree well in age with the plankton-derived lipids implying a predominantly marine source. In contrast, terrigenous biomarkers were significantly older than those derived from marine primary producers and were in good agreement with radiocarbon ages of bulk organic matter. At anoxic locations, youngest radiocarbon ages of lipids were observed implying excellent preservation of labile organic matter. In the SW and NE Black Sea, large age differences were observed between marine compounds and bulk organic matter as well as terrigenous lipid biomarkers. This implies the input of strongly pre-aged material from the steep slopes of the adjacent continents.