

Net production of ancient DOC in continental margin sediments

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Since the initial publication of $\Delta^{14}\text{C}$ values of deep-sea dissolved organic carbon (DOC) over five decades ago, the anomalously old radiocarbon age of DOC in seawater has remained an enigma. Marine sediments have long been suspected of being sources of pre-aged DOC to the water column, but $\Delta^{14}\text{C}$ values of porewater DOC in surface sediments have so far proven to be higher than the $\Delta^{14}\text{C}$ value of bottom-water DOC. Additionally, modeling work done on anoxic sediments of Santa Barbara Basin (SBB) and Santa Monica Basin (SMB) indicate that the porewater DOC at the sediment surface partially consists of ^{14}C -depleted DOC, but there have been few direct observations to corroborate this finding. Here we present new findings from three sites in the continental margin offshore California, USA (Catalina Basin and two shelf locations near Monterey), that strongly support net production of ancient DOC at these sites. In contrast to the laminated and anoxic sediments of SBB and SMB, the new study sites are under mixed-redox conditions and are bioturbated. Porewater DOC concentrations are also lower by a factor of ~5-10. Results show considerably lower $\Delta^{14}\text{C}$ values in porewater DOC in the mixed-redox sites compared to SMB and SBB, with the offset being ~250‰ in the top 30 cm of the sediment column, and by as much as 500‰ at 3 m depth. Furthermore, $\Delta^{14}\text{C}$ values of porewater dissolved inorganic carbon (DIC) from the mixed-redox sites are similar to, or greater than, $\Delta^{14}\text{C}$ of DIC in SMB and SBB. We attribute these observations to: (1) occurrence of sedimentary organic carbon with very low $\Delta^{14}\text{C}$ values at the mixed-redox sites (as low as <-990‰), and (2) efficient remineralization, especially in mixed-redox sediments, of organic matter that is enriched in ^{14}C , resulting in accumulation of ^{14}C -depleted DOC in the porewaters. We argue that redox oscillation from bioturbation not only suppresses DOC accumulation but also lowers the $\Delta^{14}\text{C}$ values of porewater DOC. If the patterns observed here hold over greater spatial scales, mixed-redox to oxic sediments with low porewater DOC concentrations could be major sources of pre-aged DOC to the water column.