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Reaction-transport modeling of pore-water DOC and its isotopic composition in Santa Monica Basin (CA) sediments

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Reaction-transport models provide important information on the bulk reactivity of POC and DOC in marine sediments and have been used to examine the role sediments play as sources of refractory and pre-aged DOC to the oceans. Overall, such efforts allow us to better understand the sources and sinks of DOC in the modern ocean. The model used here examines concentrations and isotopic signatures ($\delta^{13}C$ and $\Delta^{14}C$) of carbon pools involved in sediment organic matter remineralization (POC, DOC and DIC), and assumes that there are multiple POC pools of varying reactivity that undergo remineralization. While most (>90%) carbon flow goes through "labile" DOC intermediates to produce DIC some carbon flow (~5-10%) produces refractory DOC. The model was applied to sediments from Santa Monica Basin (SMB), California Borderlands region. SMB has a more "complex" history of recent sedimentation than other Borderland basins due to extensive turbidite deposition below the upper ~20 cm of laminated hemi-pelagic sediments. Model results show that POC undergoing remineralization in the upper hemi-pelagic SMB sediments is largely of marine origin. In contrast, POC in the deeper turbidite deposits appears to be a mixture of terrestrial POC along with relatively "fresh" and re-worked, pre-aged marine POC. Unfortunately, these model results alone cannot easily resolve these different inputs. Model results also provide evidence for enhanced consumption of reactive DOC near the sediment surface, which minimizes its escape from the sediments into the overlying water column. Possible explanations for this enhanced DOC consumption may include active iron redox cycling near the sediment surface, as well as foram denitrification (i.e., "bio-transport" of bottom water nitrate into the surface sediments by forams where they denitrify this nitrate to N_2). The $\Delta^{14}C$ signature of the model-predicted benthic DOC flux from SMB sediments is ca. +60‰, consistent with much of this flux being derived from remineralization of reactive POC in the surface sediments containing bomb radiocarbon. However, benthic fluxes of different model-defined DOC sub-fractions have $\Delta^{14}C$ signatures as low as -300‰, which provides evidence that at least a portion of the benthic DOC flux from SMB sediments contains pre-aged DOC.