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TIMESCALES OF TERRESTRIAL ORGANIC CARBON EXPORT TO THE OCEANS

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Great strides have recently been made in our understanding of the composition of organic matter discharged from rivers to the oceans, as well as its subsequent fate in the marine environment. In contrast, we know relatively little about the timescales over which vascular plant-derived organic carbon is stored in terrestrial reservoirs, moves between these reservoirs, and is discharged the oceans. This information is crucial if we are to develop accurate models that mimic carbon cycling in the environment as well as predict the impacts of anthropogenic perturbations of the natural system. Accurate interpretation of terrestrial and marine proxy records from continental margin sediments also depends upon knowledge of the temporal relationships between these signals.

Radiocarbon provides an effective tool to constrain residence and transport times of organic matter, and prior studies have revealed that the World's rivers discharge particulate and dissolved organic matter that varies markedly in radiocarbon age. However, a major impediment to the interpretation of these radiocarbon ages in terms of residence time is the unknown and potentially variable contributions of sedimentary rock and other non-vascular plant sources of organic matter to bulk phases. This complication can be obviated by targeting biomarker compounds specific to vascular plants for radiocarbon analysis.

We have performed compound-specific radiocarbon analysis on sediments recovered from fluvial deposits at the termini of several river systems spanning a range of drainage basin types, sizes, and bedrock lithologies, as well as varying in terms of climate (hydrology, temperature) regime. A first-order relationship appears to exist between terrestrial organic matter residence time and latitude, implying a strong influence of temperature on the rate of organic matter cycling within, and export from, watersheds.

In order to more tightly constrain residence times of the most active pools of terrestrial organic matter, detailed down-core molecular-level radiocarbon measurements have been made on terrestrial marker compounds preserved in anoxic marine basins adjacent to tropical and temperate drainage basins. We trace the atmospheric radiocarbon "bomb-spike" from its initial incorporation into vascular plant biomass to the downstream sedimentary sink. Lags between the known date of the bomb-spike and its manifestation in vascular plant biomarkers preserved in sediments can be interpreted in terms of residence times of terrestrial organic matter within the corresponding drainage basin. These measurements suggest vascular plant-derived organic matter exported to the oceans involves at least two components – one that is rapidly transported (< 20 years) together with a pool of slower cycling "pre-aged" material (soil). . Findings from the above studies will be discussed in terms of the controls on the export of particulate materials from rivers to the oceans and the sensitivity of terrestrial discharge to anthropogenic and climate perturbations.

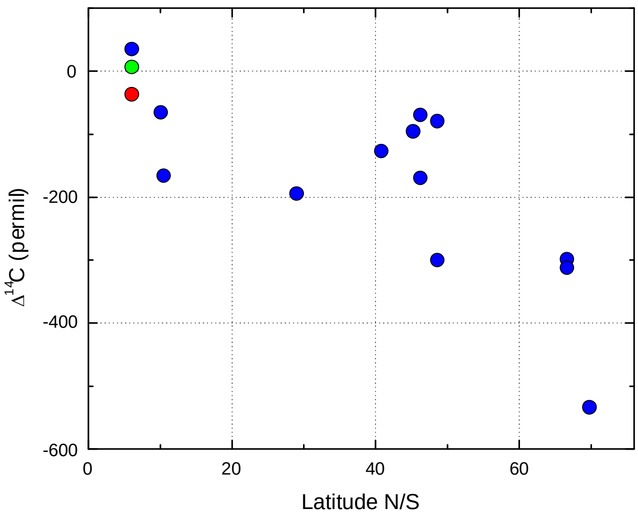

Figure 1. ^{14}C content (expressed as $\Delta^{14}C$, permil) of plant wax-derived long-chain ($\geq C_{24}$) lipids from sediments collected at the termini of river drainage basins plotted as a function of latitude (blue circles = n-alkanoic acids; green circles = n-alkanols; red circle = n-alkanes).