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Revisiting the reactivity of terrestrial organic matter along the land-sea continuum: implications for the global budget of organic carbon burial

In 1997 the late John Hedges published two landmark papers laying the foundations of the modern understanding of biogeochemical cycling of terrestrial organic matter along the land-sea continuum. John famously enunciated what two decades later remains a conundrum: “Because riverine organic matter consists of highly degraded […] remains of terrestrial organisms it might be expected to suffer minimal degradation in the Ocean. One of the biggest mysteries in the global carbon cycle thus, is that only a small fraction of the organic matter […] preserved in marine sediments appears to be land derived."

We revisited this conundrum by gathering new mechanistic and quantitative understandings of organic carbon cycling using novel analytical techniques. These include compound specific as well as ramped pyrolysis/oxidation (RPO) radiocarbon analysis. These state of the art techniques allow measuring (rather than inferring) organic carbon reactivity, stable isotope and age distributions. These techniques were used to characterize organic matter reactivity in a broad range of environments along the land-sea continuum. Using a set of illustrative examples including soils, river and marine sediments we show that mineral protection is a globally significant driver of organic matter preservation. Finally, we suggest that the persistence of mineral-bound terrestrial organic matter in marine sediments has likely been globally underestimated, thereby resolving Hedges’ conundrum.