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Early diagenesis of recently deposited organic matter: a 9-yr time-series study of a flood deposit

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Because the preservation of organic carbon (OC) in river-dominated margins accounts for a significant fraction of OC burial in the ocean, biochemical studies must find novel ways to explicitly address the non-steadiness of these settings. In this study, we approached this issue by collecting event-beds soon after their emplacement (event-response sampling) and following their evolution with time (time-series analysis). In Fall 2000, the Po River (Italy) experienced a 100-yr return period flood that resulted in a thick deposit in the adjacent prodelta. Cores collected in the central prodelta after the flood event and over the following 9 years (8 sediment cores), allowed characterization of the event-strata in their initial state and documentation of their subsequent evolution. The characterization of sedimentary organic matter (OM) collected soon after the flood deposit emplacement and the description of its subsequent evolution with time provided extraordinary opportunity to investigate the reactivity of OM on a 9-yr time scale. Our analysis included the evaluation of the whole spectrum of CuO reaction products such as lignin phenols, p-hydroxy benzenes, benzoic acids, cutin-derived products, dicarboxylic acids, and fatty acids, as well as bulk organic carbon, nitrogen and carbon stable isotopes. Sedimentological characteristics were investigated using x-radiographs and sediment texture analyses whereas the evolution of sedimentary OM was evaluated via inventories of bulk elements and biomarkers. Remineralization of organic nitrogen and organic carbon occurred at similar rates (% change $\sim$-17%) indicating that the overall elemental composition of sedimentary OM remained stable with time. This steadiness was confirmed by lack of temporal changes of the OC/TN ratio. Despite the steady OC/TN ratio, changes in δ13C revealed preferential loss of isotopically enriched organic material. Biomarker inventories indicated selective degradation during diagenesis, consistent with the reactivity spectrum observed in laboratory and field studies (% change from -$\sim$9 to -$\sim$60%). Among terrigenous biomarkers, lignin phenols were better preserved than hydroxy fatty acids derived from plant cuticles (% change $\sim$-10 vs $\sim$-50 %, respectively). Aromatic CuO reaction products, such as benzoic acids and p-hydroxy benzenes, were better preserved than lipid-derived biomarkers, especially for those compounds having a terrestrially-derived source. The largest part of dicarboxylic acids was derived from plant cuticles and exhibited reactivities coherent with cutin-derived products (% change $\sim$-50%).