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Sources and fate of particulate organic carbon in a Midwestern U.S.A. floodplain

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Soil organic matter is a large and dynamic carbon pool heavily impacted by anthropogenically mediated erosion. Up to 90% of eroded soils stay in terrestrial sediment deposits, yet little is known about the fate of carbon after deposition. We investigated the sources and fate of particulate organic carbon (POC) in an old-growth forested floodplain in the Sangamon River basin of Illinois. The floodplain has experienced increased sedimentation rates since the onset of upstream agricultural activity in the past two centuries.

We analyzed the form (organic or inorganic) and sources of POC in floodplain sediment core samples collected along a transect perpendicular to the river channel via FTIR spectroscopy, stable carbon elemental analysis-isotope ratio mass spectrometry (EA-IRMS), and radiocarbon Accelerator Mass Spectrometry (AMS) measurements. FTIR analyses revealed that there were no carbonates (inorganic C), indicating little inorganic C was deposited to the floodplain surface or formed diagenetically during burial. EA-IRMS analyses show that only 17-32% of deposited POC has been buried over the past 150 years. Further, the EA-IRMS measurements indicate a change in POC source from local ecosystem debris to allochthonous fluvial deposition with depth. Local ecosystem POC is preferentially lost during burial, presumably through oxidation, while fluvial POC persists to be sequestered on longer time scales (>100 years). We hypothesize that the transport history of fluvial POC has made it less reactive in the floodplain sediment. AMS radiocarbon measurements indicate that the POC lost is relatively young ($F_{mod} \approx 1.0$), which is consistent with a local ecosystem source. The POC sequestered has an apparent age thousands of years older than the expected age of sediment deposition, consistent with the upstream storage of alluvially delivered POC. The preferential burial of older, less reactive fluvially deposited POC appears to be the primary material sequestered, reflecting the watershed C signal. The sequestration dynamics of sedimentary depositional centers like floodplains lends insight into the long-term impacts of soil erosion on the terrestrial carbon cycle.