Tracking organic carbon across the Andes-Amazon transition with terrestrial biomarker isotopes

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Major mysteries remain unsolved about the dynamics of organic carbon erosion and transport in large river systems that encompass actively eroding headwaters and extensive depositional floodplains. These rivers account for the largest point sources of carbon to the oceans and are important in linking tectonics to the organic fluxes in the global carbon cycle. Growing literature has focused on mechanisms of organic carbon erosion in mountainous settings and preservation in sediments. In this work, we turn attention to the role of floodplains and consider the relative importance of lowland versus mountain environments in determining the total fluxes and composition of organic matter exported by rivers.

We have assessed the roles of mountain and floodplain erosion of carbon across the transition from the Andes to the foreland Amazon floodplain in southeastern Peru. We tracked organic carbon sources using hydrogen isotope (D/H) and radiocarbon (14C) composition of terrestrial-derived leaf waxes separated from particulate organic carbon (POC) in river sediment. D/H ratios identify elevational source of POC because they carry the fingerprint of precipitation D/H that varies systematically with elevation. POC in lowland rivers is dominated by leaf waxes with low elevation D/H signals. A maximum contribution of ~10% high elevation leaf waxes to POC at low elevations reflects the much larger lowland area. Observed variability is too large to use the D/H to distinguish whether high-elevation POC is replaced or simply overwhelmed by lowland material, but either way montane organic matter comprises a small proportion of the total flux.

Radiocarbon ages of leaf waxes from POC are young in mountain headwaters (as young as <500 yrs old) and increase across the floodplain (up to >1000 yrs). Leaf waxes from soil organic horizons are all very young (>modern radiocarbon), independent of elevation. The older signal in river sediment POC is likely sourced from mineral soils that are progressively more aged downstream, implying increased average residence time despite the large total organic carbon flux from the lowlands.