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Terrestrial biospheric carbon export from rivers by bedload transport

Sophia Dosch[1,2], Hovius Niels[1,2], Repasch Marisa[1,2], Scheingross Joel[3], Turowski Jens[1], and Sachse Dirk[1]

[1]German Research Centre for Geoscience (GFZ), Potsdam
[2]University of Potsdam, Germany
[3]University of Nevada, Reno

Rivers are natural conveyor belts distributing the products of erosion across Earth's surface. If river biospheric organic matter survives long-distance transport and fluvial reworking, it can be deposited and buried in marine depozones, acting to remove carbon from the short-term carbon cycle and draw down CO_2 from the atmosphere to a carbon sink over geological time scales.

It is estimated that globally, river suspended sediment fluxes deliver up to 230 MtC yr^{-1} biospheric particulate organic carbon (POC) to the ocean. In addition to this commonly measured POC, coarse particulate organic matter (CPOM, > 1mm) has been observed to travel with bedload in modern rivers. Several studies describe terrestrial coarse litter and woody debris buried in sandy turbidite layers and capped by muddy sediment, suggesting effective transport and burial of coarse, relatively fresh organic material to marine depozones.

However, it is unknown whether this CPOM derives from distal sources and survives long-distance fluvial transit, or if distal material is degraded during transit and replaced by CPOM from sources proximal to the coasts. Furthermore, fluxes of CPOM travelling at the river bed are largely unknown, making it an important, yet largely unconstrained term of the carbon budget. Here we investigate the fate of bedload CPOM transported over long distances to determine whether it is preserved, deposited, or degraded and replaced during fluvial transit.

We sampled river bed material from several locations along the Río Bermejo, an intracontinental lowland river in northeast Argentina. At each sampling location, we found substantial amounts of organic matter, together with clastic sediment, from the river bed. To trace the source of the CPOM, we extracted leaf wax n-alkanes and measured their stable hydrogen isotope ratios (d^2H_{wax}). We compared d^2H_{wax} of bed CPOM to d^2H_{wax} of river suspended sediment, soil and litter samples from the river catchment in order to determine its provenance and transport pathway.

Changes in biomarker distribution suggest that the organic matter is recruited from local sources along the river, either as plant debris or as partly degraded litter. In addition, CPOM becomes more degraded, while the n-alkane concentration increases with increasing downstream transport. Our initial data suggests that CPOM is derived partly from distal sources and preserved during fluvial transit. While some part of the CPOM is likely to be oxidized to CO_2, fresh input is added along the way, potentially overprinting the upstream signal.

With additional measurements of stable carbon isotope ratios, we expect to verify the source and the fate of the bed CPOM. While it is difficult to quantify the flux of bedload CPOM, we plan to present a first-order approximation by combining river bed flow velocities measured via acoustic doppler current profiler (ADCP) and measurements of CPOM mass collected over our sampling times.