

Weathering of organic-rich shales controls black carbon export via rivers

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Erosion of petrogenic organic carbon (OC) from the terrestrial biosphere links lithology, climate, and the evolution of atmospheric CO₂ over geologic timescales. When liberated, some fractions of petrogenic OC are rapidly oxidized to CO₂ (Bouchez, 2010) and others are passively translocated from land to sea via rivers (Galy et al., 2008). Black carbon (BC) is the condensed aromatic fraction of OC and comes in a variety of forms like charcoal, soot, petroleum, and graphite-like materials. Once produced, BC is relatively unreactive, stable on short and long timescales, and is environmentally long-lived. In the Hudson River (New York, USA), we show particulate BC to be derived from shale weathering. Riverine suspended particulate material was collected from March 2021 to May 2022 at different flows, along with endmember shale samples. Particulate BC was quantified following the benzenepolycarboxylic acid method. BC-specific stable isotope values decreased by ~3‰ between base and peak flow conditions. The relationship between BC stable isotope values and normalized discharge is exponential, where the asymptote approaches that of BC in organic-rich Utica shale. The radiocarbon age of particulate BC in rivers varies globally (Coppola et al., 2019) and may be better explained by underlying lithology than wildfire activity. Together, these results suggest particulate BC may be a conservative tracer for petrogenic OC deriving from shales and preferentially mobilized under moderate-to-high flow conditions, solidifying a link between short- and long-term carbon cycles.

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