Carbon isotope composition of particulate organic carbon (POC) in rivers

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ABSTRACT

Rivers assume an important role in carbon cycles as they are key transporters of material from continents to oceans. This also includes turnover and recycling of material within rivers. For instance, recent work classified continental waters not only as transporters but also as sinks for carbon (Battin et al. 2009). Before carbon-containing material settles in sediments, various interactions between its particulate and dissolved forms may also influence their concentrations in the water column. For instance, turnover of dissolved inorganic carbon (DIC) to particulate organic carbon (POC) via algal activities may increase the biomass that may later be stored in sediments. Such interactions can be investigated by concentration measurements of the various phases involved. In addition, their stable isotope characterisation may help to quantify turnover and origin of material. For this technique natural abundance $^{13}C/^{12}C$ variations are expressed as per mille (‰) deviations from the international Vienna Pee Dee Belemnite (VPDB) standard (Clark and Fritz, 1997). POC is a variable mixture of living and dead phytoplankton and other components such as detritus, bacteria and zooplankton (Fogel et al., 1992). Among these components, the major sources of riverine POC are terrestrial detrital matter or phytoplankton that was produced in the water column. The latter process changes the aqueous CO_2 content and the $^{13}C:^{12}C$ ratios of dissolved inorganic carbon (DIC). During photosynthesis, aquatic plants utilize aqueous CO_2, a process that preferentially removes ^{12}C from the DIC pool. This mechanism explains the isotope discrimination between DIC and phytoplankton (Fry and Sherr, 1984). The isotopic composition of POC ($\delta^{13}C_{POC}$), if resulting from algal photosynthetic activity, should therefore reflect that of DIC ($\delta^{13}C_{DIC}$), but at a more negative level. With this their isotopic differences plot against free CO_2 in the water column (Rau et al., 1996). This concept was tested in the St Lawrence River and revealed that most DIC and POC samples from embayments adhered to the model (Barth et al., 1998). Mostly riparian ecosystems in rivers can play an important role in the riverine carbon cycle. Similar studies are also currently carried out in Franconian Rivers such as the Main, the Bucher Landgraben and the Aisch.

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