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Decomposition and transformation of 14C labeled black carbon in soil

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Incomplete combustion of organics (vegetation or fossil fuel) led to accumulation of charred products in soils. Such charred products, frequently called black carbon (BC), may act as an important long-term carbon (C) sink because its microbial decomposition and chemical transformation is very slow. There are no studies with direct estimations of BC decomposition rates and its transformation in soil.

We produced BC by charring 14C labeled residues of perennial ryegrass and incubated this 14C labeled BC in a Haplic Luvisol or in loess. The decomposition rates of BC were estimated based on $14CO_2$ sampled 55 times during the 7-years incubation period. The decomposition rates of BC calculated based on 14C in CO_2 were similar in soil and in loess and were about 10-5 d-1 (=10-3 % d-1). This corresponds to a decomposition of about 0.3% BC a-1 under optimal conditions. Considering about 10 times slower decomposition of BC under natural conditions, the mean residence time of BC is about 2000 years.

Three years after the incubation start, we traced the BC transformation in soil by 14C incorporation into microbial biomass, DOC, PLFA, sugars, neutral lipids, glycolipids, sugars and benzene polycarboxylic acids. The most 14C (>80%) remained in benzene polycarboxylic acids confirming very high stability of BC. Incorporation of BC-14C into microbial biomass, DOC and PLFA was less than 0.5%.

We conclude that despite very high stability of BC and very slow process rates, the application of 14C labeling opens new ways for very sensitive tracing of BC transformation products in released CO_2, microbial biomass, DOC, and SOM pools with various properties.