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Advanced 14C dating on organic carbon with distinct bond strengths for terrestrial carbon cycling dynamics

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Abstract
Protective and selective preservation of OC are two carbon sequestration mechanisms that are hypothesized and quantified only by conceptual models. However, evidence of protective preservation is reported only in occlusion and pore spaces and selective preservation is mainly observed in fluvial sediments. Here, we use a specially-designed pyrolysis-combustion device to extract pyrolysis labile and recalcitrant molecules via O2-free thermal decomposition and pyrolysis inert molecules via pure-O2 combustion of the graphitic-like residue on a given sample for AMS 14C dating to quantify OC cycling dynamics. These OC fractions with measurable bond strengths from wide range of terrestrial sediments including lacustrine, mollisol, Yellow River wetland, loess, karst mountain rock vanish in China and previous daylight-free caves and engineered/managed soils in the U.S.A. and Japan show instant and hysteretic protection and elsewhere selection and in-situ dissipative mechanisms. The instant protection indicates that low energy OC molecules could yield older than or identical to 14C dates of high energy molecules. The hysteretic protection and dissipative selection dynamics that occur in high OC production environments provide a potential to improve accuracy of sediment chronology. The elsewhere selection-to-redistribution mechanism always predates the redistribution events with unpredictable 14C dates-depth trajectories.

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