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Molecular-scale radiocarbon dating of charcoal and black carbon

Rienk H. Smittenberg (1), Maximilian P.W. Schneider (1), Irka Hajdas (2), Wacker Lukas (2), Stefano. M. Bernasconi (3), and Michael W.I. Schmidt (1)

(1) Department of Geography, Soil Science & Biogeography, University of Zurich, Switzerland (rienk.smittenberg@geo.uzh.ch), (2) Ion Beam Physics, ETH Zurich, Zurich, Switzerland, (3) Geological Institute, ETH Zurich, Zurich, Switzerland

Graphitic-aromatic organic molecules of various sizes, together often referred to as 'Black Carbon' (BC), are known for their persistence in the environment, thus forming a significant part of the long-term global carbon cycle. For instance, this molecular mass of BC can make up to 30% of total carbon in certain environments that experience regular wildfires. Furthermore, they are the molecular counterparts of charcoal, one of the main substances used for archaeological dating. From both a carbon cycle and an archaeological perspective radiocarbon (14C) dating of BC is highly desirable, yet proven difficult on a molecular scale. One method to analyze the amount of BC, and its degree of aromaticity - a proxy for charring temperature, consists of nitric acid digestion and subsequent analysis of the resulting benzenepolycarboxylic acids (BPCA) by gas chromatography (GC) or liquid chromatography (HPLC) (Schneider 2011). Previous attempts to perform 14C analysis of BPCAs using preparative GC proved doable but difficult (Ziolkowski 2009). We present the first results of an HPLC-based method to separate and collect individual BPCAs for subsequent 14C dating on a Mini Radiocarbon Dating accelerator mass spectrometer, equipped with a gas ion source. This new method opens up new ways to determine the age of BC in soils, sediments and other matrixes, thus allowing for quantification of long-term turnover times of BC in the environment. Moreover, the presented method may allow molecular-scale 14C dating of archaeological sites lacking discrete pieces of (micro)charcoal or other means of dating.

References:
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