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Radiocarbon analysis of isoprenoid and branched Glycerol Dialkyl Glycerol Tetraethers in soils and fluvial sediments

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Glycerol dialkyl glycerol tetraethers (GDGTs), membrane lipids synthesized by archaea (isoprenoid GDGTs) and bacteria (branched GDGTs), form the basis of a suite of molecular proxies used in terrestrial as well as marine environments. Compound-specific radiocarbon analysis has provided valuable insights into the sources and yielded constraints on transport dynamics of different biomarkers in the context of carbon cycle processes. To complement the existing biomarker radiocarbon toolbox, and to shed new light on the sources and fate of GDGTs, we developed a new method to measure GDGT radiocarbon compositions in natural samples.

Isoprenoid and branched GDGTs are isolated using two UHPLC silica columns in series coupled to a fraction collector set to eluent recovery at different time intervals. The accuracy of the method was tested using a modern and a radiocarbon-dead reference material. Procedural blanks show that the separation procedure adds less than 3 µg carbon with a Fm of 0.64.

The method is first applied to determine the $\Delta^{14}C$ composition of isoprenoid and branched GDGTs in two soil core profiles from a temperate and subalpine forest ecosystem in order to explore the range of typical values encountered in natural systems. The cores, which reach a depth of 80 cm and 40 cm respectively, have previously been analyzed with respect to radiocarbon characteristics of long-chain n-alkanes and fatty acids as well as bulk particulate and dissolved organic carbon (OC) [1]. For each core, GDGTs were separated and analyzed from 3 different depth intervals. The $\Delta^{14}C$ of both isoprenoid and branched GDGTs decreases, at a similar rate as the bulk, by -350‰ and -200‰ along the temperate and the subalpine core respectively, hence confirming their potential for constraining transport-dynamics of soil-derived matter in rivers.

The radiocarbon age of GDGTs in a suite of fluvial sediments is older than expected under the assumption that topsoil-derived organic matter is the main source of the compounds. Potentially, this offset could be caused by rapid degradation of the compounds during transport and therefore alter the proxy signal on the way to sedimentary archives.

[1] van der Voort, T. S., et al., 2017 - Geophysical Research Letters 44, 23