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Improved quantification of pyrogenic carbon in soils and sediments by a HPLC-DAD method

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Fire-derived (pyrogenic) carbon (PyC) is produced by the incomplete combustion of biomass, for example during wildfires. It can persist in the environment for a long time due to its relative resistance against biological and chemical breakdown. Its accurate quantification in soils and sediments is of great interest because the slow turn-over of PyC has implications for the global carbon cycle and carbon budget calculations. Moreover, PyC in pedological and sedimentological records can be used to reconstruct wildfire history or to investigate historical periods like the industrialization.

A whole suite of PyC quantification methods exists because PyC is not a defined chemical structure but rather a continuum of thermally altered biomass. The benzene polycarboxylic acids (BPCA) analysis is a molecular marker method that was shown to give conservative estimates of PyC quantity in soils. In addition, it yields qualitative information about the degree of aromaticity and condensation of PyC. The commonly used BPCA method consists in digesting samples with nitric acid that breaks down the PyC into a suite of BPCAs, which are cleaned, derivatized and finally analyzed by gas chromatography-flame ionization detection (GC-FID).

Here, we present a modified BPCA method for soils and sediments that uses a high performance liquid chromatography system coupled to diode array detection (HPLC-DAD). We demonstrate that this method greatly enhances the reproducibility of PyC quantification in soil and sediment samples while significantly reducing analysis time. Moreover, much less sample material is needed for precise PyC quantification and we show that the HPLC-DAD method yields consistently higher PyC contents than the GC-FID method. Additionally, the modified method also facilitates δ13C and 14C measurements of the PyC fraction in these complex matrix samples. The isotopic information further improves the assessment of PyC budgets in the environment and the reconstruction of past burning events.