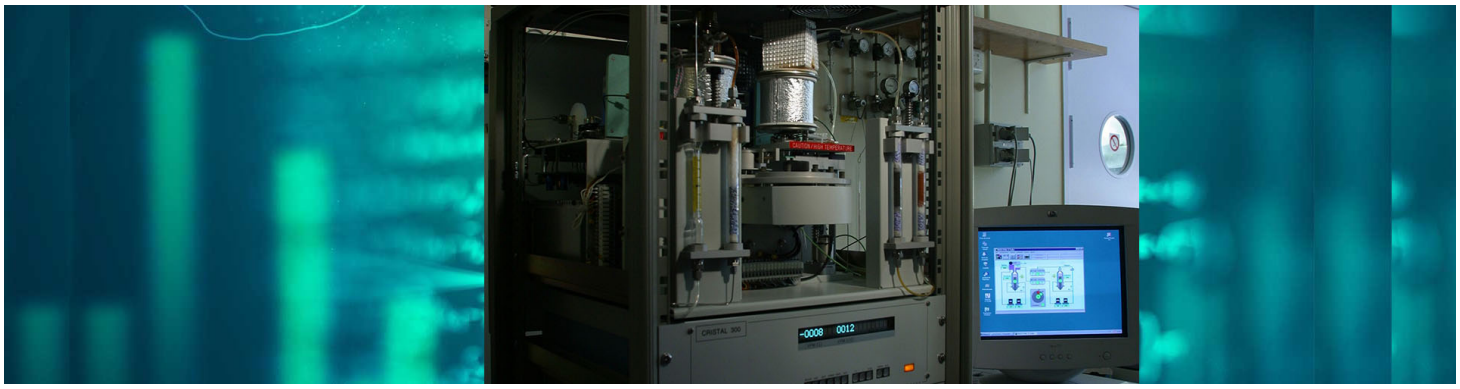

Written on 20 December 2024 3 minutes of reading

News

Fundamental Research

Soil analysis and characterization

Geochemistry

Biochar is a solid, carbon-rich (>60%) residue obtained via the pyrolysis of biomass [1]. It is generally produced for spreading on agricultural land with a view to increasing carbon storage by the soil. Once mixed into the soil, the biochar particles break down very slowly meaning that they can remain in the environment for several hundreds of years [2]. In order to understand and track biochar flows in the environment, it is necessary to be able to quantify them. IFPEN proposes a new method for this purpose, based on Rock-Eval® thermal analysis.

Direct and rapid quantification

Existing methods for quantifying biochar in soils employ oxidation (thermal or chemical), optical identification and molecular marking techniques. The drawback with these methods is that they are time-consuming and/or manipulator-dependent [3]. Rock-Eval® proposes a thermal analysis method developed by IFPEN, making it possible to precisely measure organic and mineral carbon present in the soil. The method offers the advantages of being direct (no pre-treatment required) and relatively rapid (around 1 hour per sample).
Rock-Eval® comprises two ovens, one for pyrolysis and the other for oxidation. During an analysis, a sample is successively pyrolyzed and then oxidized at defined temperature ramps. **Carbon**

emissions in the form of hydrocarbons, CO and CO_2, are measured over time to create five thermograms, each corresponding to a specific type of carbon emission during one of the two phases.

Biochar: a specific thermal signature

The study related to soil-biochar mixtures obtained from four cultivated soils and **six biochars from different biomasses (herbaceous, corn, compost, miscanthus, wood and rapeseed)** pyrolyzed at temperatures of between 400 and 650°C. Soils and biochars were mixed in six ratios ranging from 0.05 to 1% by mass.[4]
For all of the mixtures, **the presence of biochar caused the emission of a CO_2 peak, during the oxidation phase, at between 410 and 610°C** (figure 1). This CO_2 corresponds to carbon emissions from stable molecules that could be related to the presence of biochar, but also to biomass that has been pyrolyzed during a forest fire, for example. It may also correspond to chemically stable and non-pyrolyzed substances naturally present in the soil prior to the addition of biochar, such as lignin.

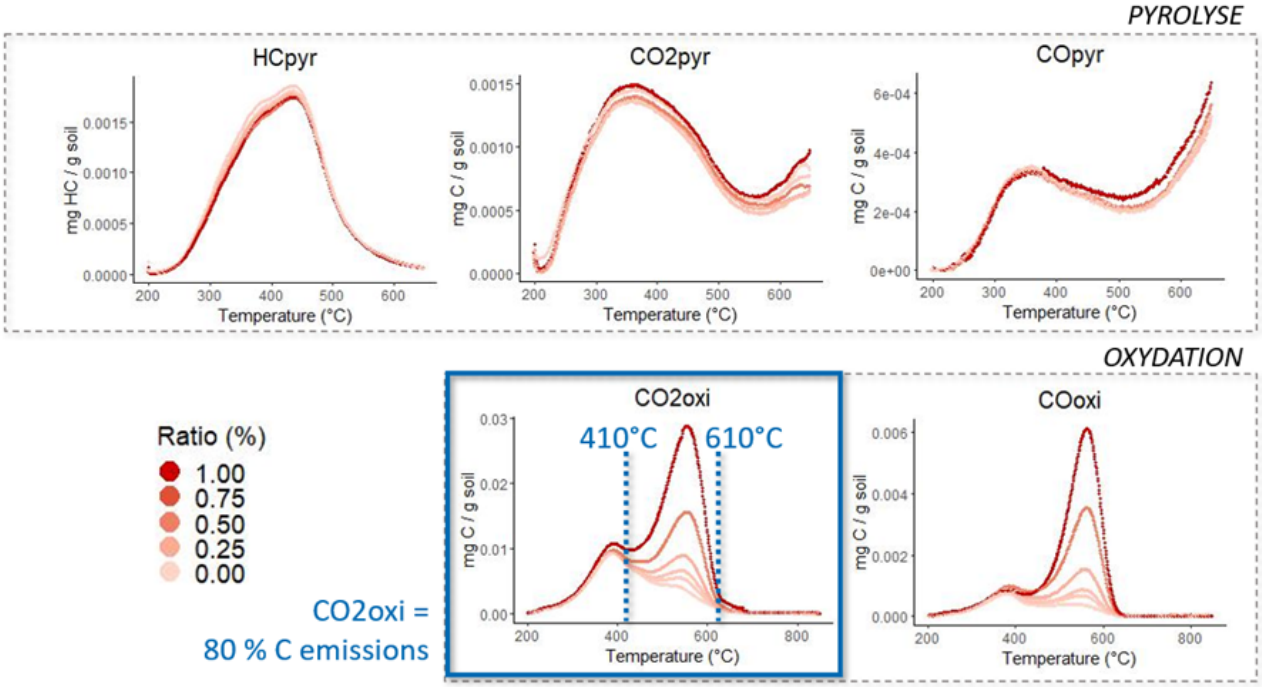

Figure 1: Emissions of hydrocarbons (HC), CO and CO2 from pyrolysis (pyr) and oxidation (oxi) during Rock-Eval® analysis of soil-miscanthus biochar mixtures.

Precise and scalable quantification

Since biochar contains a higher concentration of carbon than the soil, its presence results in a real CO_2 peak (CO_2oxi), which is particularly pronounced when the “pure” soil, prior to the addition of biochar, is low in organic carbon (< 4-5%), which is often the case with cultivated soils. **The area of this peak**, when adjusted for the influence of the soil over this same temperature interval, **gives a very good estimation of the quantity of biochar in the mixtures** (figure 2). However, this method

does require the analysis of the pure soil, prior to the addition of biochar. In the absence of this reference, it is still possible to use the sample of mixture containing the smallest peak and obtain a relative estimation of the quantity of biochar added.

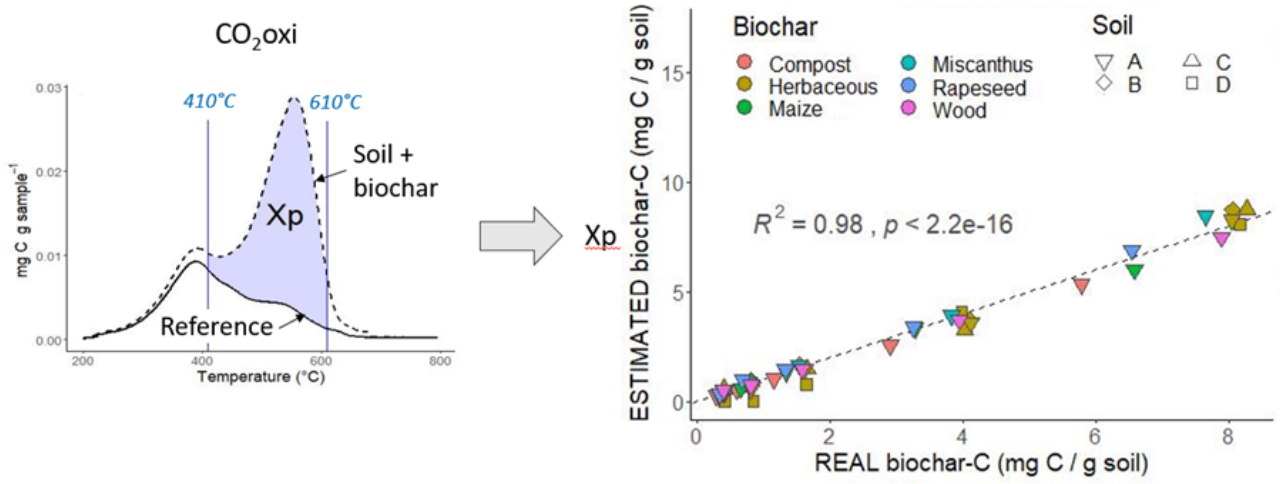

Figure 2: Estimation of the quantity of carbon from biochar in soil-biochar mixtures, relative to the reference soil containing no biochar.

Method applications

Soil amendment with biochar is generally carried out on agricultural land, which explains the need for quantification in cultivated soils. However, the technique is also of interest for urban soils. IFPEN is currently working on two urban soil projects where it will be applied: the ADEME Response project and the ANR Optisoil project. **Over time, biochar particles can be transferred to forest or grassland soils, which naturally contain more carbon**. Consequently, it is necessary to quantify biochar in these soils in order to monitor what happens to the particles in the environment. Lastly, carbon quantification in archeological soils is also of interest, since it provides an insight into the human activities behind these carbon deposits.
In addition to quantifying biochar in soils, **Rock-Eval® can also be used to compare the characteristics of "pure" biochar**, providing information on total carbon content and the proportions of thermolabile (pyrolyzable) and thermo-resistant carbon, the values of which depend on the biomass used and the pyrolysis conditions. This information is useful for controlling the quantity of biochar at the end of production or prior to application.

Références:

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Scientific contacts: Marie-Liesse Aubertin, David Sebag

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