Hydrogen dynamics in soil organic matter as determined by ^{13}C and ^{2}H labelling experiments

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Carbon and water dynamics in soil organic matter are of major importance when trying to predict the behaviour of ^{14}C and ^{3}H in terrestrial environments at local or global scales. Carbon has been widely studied to assess the organic matter dynamics in soil. When looking at ^{3}H behaviour, organic hydrogen dynamics is of major importance but has received poor attention until now. Hydrogen bound to N, O or S atoms is exchanged very quickly with ambient water and water vapour. Hydrogen bound to a carbon atom, so called "Non-Exchangeable Hydrogen" (NEH), is considered more stable. To study the fate of hydrogen in various soils, ^{2}H coupled to ^{13}C isotope are used. We hypothesized that the acquisition of the NEH isotope signature is determined by the dynamics of carbon in soils. Two main processes are involved: the partial preservation of the isotopic composition of initial vegetation matter, and the microbial biosynthesis incorporating hydrogen with water isotopic composition.

To decipher and quantify both processes, we designed incubation experiments of ^{13}C-labelled organic substrates, with two scenarios: either $^{13}C^{2}H$ double labelled molecules in presence of $^{1}H_2O$ or ^{13}C molecules in presence of $^{2}H_2O$. Over time, ^{13}C content of bulk samples were analysed by Elemental Analyser-Isotope Ratio Mass Spectrometry and the simultaneous ^{13}C and ^{2}H content with a Combustion Module-Cavity Ring-Down Spectroscopy Isotope Analyser.

Our first results showed that in one month, 70% of the carbon of the substrate added to the soil has been mineralised and almost 90% of the organic hydrogen has been mineralised and/or isotopically exchanged; 10% of NEH is conserved from the molecule and about 20% of the hydrogen isotopic composition is derived from the water. The short-term dynamics of hydrogen is driven mainly by the incorporation of organic hydrogen from water by isotopic exchange and by microbial biosynthesis. From these experiments, the long-term behaviour of hydrogen derived from plant material will be predicted by modelling.