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Radiocarbon dating of magnetic and non magnetic soil fractions as a method to estimate the heterotrophic component of soil respiration in a primary forest of Ghana.

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We estimated the heterotrophic component (Rh) of soil respiration in a primary forest of Ghana by radiocarbon dating, a method we already successfully applied in temperate and Mediterranean forests. In this case, given the advanced stage of alteration of tropical soils, which are thus rich in oxides, we implemented the method on soil fractions obtained by High Gradient Magnetic Separation (HGMS), hence based on different degrees of magnetic susceptibility. In particular, we separated an organic pool associated with magnetic minerals (e.g iron oxides) from an organic pool engaged with non-magnetic minerals. This non destructive method of fractionation, often applied to the finest fraction of soil (clay), is here attempted on the bulk fine earth (< 2 mm).

We sampled the soil at 0-5, 5-15, 15-10, and 30-50 cm depth intervals, since a previous study in the same site suggested that only the first 50 cm of soil was enriched in bomb carbon (C younger than 1950). The samples of each layer were sieved at 2 mm and further at 0.5 mm ,so as to have two size fractions: 2 to 0.5 mm and <0.5 mm, and both of them were separated into a magnetic and non magnetic fraction. All the specimens were then investigated in terms of mineralogical assemblage (by X-Ray diffrattometry), chemical structure of the organic component (13C NMR spectroscopy), and 14C concentration (AMS) for inferring the mean residence time (MRT) of the organic component in the soil.

Radiocarbon concentration was always higher in the finest SOC fractions (<0.5 mm), with the magnetic fraction always showing an higher 14C concentration than the non magnetic one. The magnetic and non magnetic materials of the coarser fraction (0.5-2 mm) showed quite similar 14C concentrations in all of the soil layers investigated. The composition of the organic matter is different in the different fractions and partly explains the differences in MRT, although a major role in preserving the organics from decomposition is probably played by the physical protection in aggregates. Surprisingly, the non magnetic fraction is not influenced at all by the bomb C (negative delta 14) already at a depth of 5-15 cm and, even, at 15-30 cm all the four fractions have pre-bomb C, which means relatively high radiocarbon age.

The finest fractions are the main contributors to the Rh flux, particularly the magnetic fraction (<0-5 mm) which show also the higher C concentration among all fractions, opposite to the non-magnetic one that is poorer in C.

The Rh flux, estimated from the mean residence time of the fractions and their C amount, allowed to get a more precise estimate with respect to a previous one performed at the same site with radiocarbon analyses on bulk soils. The Rh flux from soil is hard to be estimate based on radiocarbon analysis of the bulk soil alone, and only by means of a SOC fractionation the Rh flux can be estimated quite accurately.

This alternative approach for estimating the Rh component of CO_2 from soils of tropical areas is currently being applied in 10 tropical forest sites in western and central Africa in the context of the ERC Africa GHG project, and together with measurements of the C inputs annually entering the soil will allow determining the sink-source capacity of primary forest soils.