



Transport of black carbon in fire-affected soils

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Introduction

Wildfires yield large amounts of CO₂ and NO_x to the atmosphere whereas considerable portions of severely or partly charred necromass are incorporated into the soil. Due to the highly refractory nature of such thermally-condensed products, they are assumed to increase the passive SOM pool. However, measurements of black carbon (BC) production and loss processes are not balanced. Assuming that biomass burning occurred at the same rate than nowadays since the last glacial maximum, black carbon should account for 25 to 125% of the total soil organic carbon pool(Masiello, 2004). In situ degradation, erosion but also translocation within the soil profile may be responsible for the obvious BC loss.

In order to unveil the role of translocation, the chemical compositions of organic matter in the potentially mobile (dissolved organic matter; DOM, and particulate organic matter; POM) and immobilized fractions (mineral associated organic matter of the silt and clay fractions) of burnt and unburnt soils are compared as function of the soil depths. Laboratory experiments are presently performed to examine transportation of BC in POM and DOM within the soil column.

Material and Methods

Sample material derived from the A and B horizons of various soils in Spain, Southern Portugal and the Pantanal (Brazil) which experienced vegetation fires one to 15 years before sampling. When possible, control soils with comparable pedogenesis but without fire history were taken. DOM samples were prepared by extraction with water

and subsequent filtration (0.45 μm). The density fractions were yielded after addition of $\text{Na}_6(\text{H}_2\text{W}_{12}\text{O}_{40})$ solution (density = 1.8 Mg m^{-3}). Subsequently, the mineral residue was separated into sand (2 mm to 63 μm) and coarse silt (63 to 20 μm) by wet sieving. The finer fractions were separated in a SPLIT-chamber into medium silt (20 to 6 μm), fine silt (6 to 2 μm) and clay ($< 2 \mu\text{m}$). Total carbon (C_t) and nitrogen (N_t) were determined by dry combustion (975°C) using an Elemental Vario EL analyser. The chemical composition of the fractions was analyzed by solid-state ^{13}C NMR spectroscopy with a Bruker DSX 200. For the laboratory experiment charred grass material was placed on top of a soil column, containing material from a B horizon from which organic matter was removed by H_2O_2 . After incubation for several months, the soil column is separated into three layers which are analyzed for its soil organic matter composition.

Results

Our results show that already one year after a fire event, a considerable amount of charred residues was already incorporated into the Ah horizon, whereas the litter layer predominantly consisted of fresh plant litter lost from the decaying trees. The sandy texture of some of the studied soils offers only few reaction sites for organic matter adsorption which could contribute to the stabilization of the charred residues. This may explain why in those soils most of the charred residues was recovered with the POM and DOM fractions. After rain fall, this fraction can easily be translocated with the infiltrating water and thus contribute to a relative enrichment of aromatic structures from charred residues in the deeper horizons. Oxidation of those compounds prior to transportation increases the solubility and the formation of colloids which could facilitate this process. Such transport may also be responsible for the dark colored horizon at a depth of 130 cm in a Planosol from the Pantanal. Solid-state ^{13}C NMR analysis revealed that the organic matter of this layer is dominated by aromatic structures in which almost every third C is substituted by a carboxyl group.

Masiello, C.A., 2004. New directions in black carbon organic geochemistry. Marine Chemistry, 92, 201-213.