Structural transformations of humic matter in terms of fire intensity as revealed by changes in the assemblages of pyrolytic products

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Both the quality and quantity of soil organic matter (SOM) are severely affected by fires, with widely variable effects depending on numerous factors such as fire intensity, duration, and the amount and auto-combustibility of vegetation and litter (Neary et al., 1999). Research is still controversial: although is widely accepted that charring turns labile organic components (carbohydrates, amino acids) into recalcitrant aromatic and heteroaromatic forms (Almendros et al., 2003), greater decomposition of SOM after fires has also been reported (Fernández et al., 1997). In this work the structural changes of SOM with progressive heating were monitored by using Pyrolysis-Gas Chromatography/Mass Spectrometry (GC/MS). For this purpose, sapric peat from Galicia (Northern Spain) was subjected to laboratory-controlled isothermal heating at 350 °C for 60, 90, 120, 150 and 180 s, and analysed by Pyrolysis-GC/MS using a Curie-point pyrolyser attached to a Varian Saturn 2000 GC/MS.

The results showed that at low fire intensities (<120 s of heating time) the alkyl fraction increased and the carbohydrate fraction decreased, with no significant changes in the relative amounts of the other macromolecular constituents. This indicates a selective effect of fire on the aliphatic moiety: whereas carbohydrates are gradually degraded, the alkyl compounds seem to be somewhat resistant to the low-intensity fires. However, the concentration of short chain (<20 C) alkyl compounds with even number of C (C2n) within this fraction would indicate that this quantitative resistance consists, in fact, of the cleavage of the longer alkyl compounds into shorter ones, concomitant with thermal alteration of those from plant origin (odd-C numbered alkyl chains). At 120–150 s of heating time the concentration of non-methoxyphenolic aromatics increased dramatically, at expenses of the alkyl and N-containing fraction. At these fire intensities, the transformation of SOM emulates several features characteristic of the biological humification processes occurring in the course of hundred or thousands of years, and contributes to accumulate recalcitrant C forms into the soil. However, at very high fire intensity (180 s of heating time) this humification-like effect disappeared, and the remaining fractions consisted mainly of alkyl compounds (79%), with prevalence of the long-chained ones (>20 C), followed by non-methoxyphenolic aromatics (18%); the

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other groups of compounds were drastically reduced or not detected. This composition resembles to that of a ‘protokerogen-like’ humic material, characterized by a conspicuous recalcitrant domain of thermally-resistant alkyl fraction. These results suggest that fire intensity affects the structure of humic substances following systematically diverging pathways: depletion of carbohydrate at low intensities, oxidative transformation similar to that of the humification processes at medium-high values, and formation of recalcitrant protokerogen-like material at very high fire exposure.

Referencias

