Turnover of charcoal in fire-prone mineral soils of Southern Europe
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As a consequence of a global climate warming, extended dry and hot periods are predicted, which favor vegetation fires and the production of charcoal. Incorporated into the soil, this material is considered as highly recalcitrant and to increase the soil C sink. Recent laboratory experiments indicated that under optimal conditions, plant-derived pyrogenic organic matter (PyOM) can exhibit very short residence times < 100 years. On the other hand, charcoal artifacts in fossil sediments and Neolithic soils seem to contradict with those observations, confirming that although degradation occurs, some PyOM survives on a long term scale. To bring some light onto the fate and stability of PyOM, soil chronosequences with different recovery time after fire were analyzed for soil organic matter (SOM) composition and PyOM content. The respective alterations were related to SOM degradation rates determined in controlled laboratory respiration experiments.

For the first chronosequence (Histic Humaquett) (Marshland of Doñana National Park, Southern Spain), samples were collected directly, 15 years and 19 years after a severe fire and from comparable locations that remained unaffected. The fire combusted the whole O layer (0–20 cm) and increased char content in the A horizon. Directly after fire, no PyOM was identified in deeper soil regions. After 19 years, the O layer recovered to approximately 5 cm, but only minor PyOM contributions were identified after acid dichromate oxidation. The mineral soil, on the other hand, revealed PyOM contents of up to 18% of the total C at depths > 30 cm. This clearly evidences a downward translocation of PyOM within the soil profile. Fast translocation of PyOM was also observed for a Cambisol from Central Spain, where PyOM content in the A horizon decreased from 30% to 24% within 1 and 24 years after fire mostly due to degradation. Comparable short turnover rates were determined in controlled laboratory studies of charred topsoils from Sierra de Aznalcóllar, Southern Spain, taken 1 month after an intense fire. The high carboxyl C contents typically detected in the aged PyOM increases its water solubility, allowing the observed downwards movement of PyOM in the soils. Further, the higher polarity enhances its susceptibility to microbial attack on the one hand, but also to adsorption on the mineral phase. The latter is likely to be an important mechanisms contributing to the high recalcitrance of PyOM in some environments.

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