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The impact of pyrogenic C on soil functioning : a study using ancient killn soil as a model system

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The long-term effect of pyrogenic C on the physicochemical and biological functioning of soils is poorly understood. We used ancient killn soils as model systems in order to investigate soil properties after four centuries of pyrogenic C addition. In particular we were interested in the effect of the pyrogenic C amendment on the (micro-)biological functioning of the soil. We analysed for physicochemical properties, C mineralisation as well as C dynamics following input of 13C labelled charcoal and plant residues.

Our results show compared to soil without any addition, that pyrogenic C amendment led in the long term to more rapid decomposition of the new materials. The decomposition rate was increased by about 17%. In contrast,a negative priming effect reduced soil organic carbon mineralization by about 30%. Soil physicochemical poperties, i.e. clay content, cation exchange and nutrient availability were durably improved in soil amended with pyrogenic C four centuries ago. These changes probably promoted higher microbial activity and thus intense mineralization when new plant litter was added. On the contrary, charcoal was degraded at a similar rate compared to soil without pyrogenic C amendment. Thus no specific adaptation of microorganism to charcoal degradation was observed even after several centuries. The negative priming effect induced by charcoal additiion can be due to a physical protection of the soluble carbon fraction at the surfaces of new charcoal. In contrast, the negative priming effect induced by plant residue input may be more likely due to a shift of substrate utilisation by microbial communities evolving in a nutrient-rich environment.

Our results demonstrate that pyrogenic C addition modifies the carbon dynamic of soils in the long-term. We propose a conceptual model accounting for the alterations of soil functioning in the long term after pyrogenic C addition.