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Mechanisms of charcoal degradation during its initial stages of decomposition

Nimisha Singh, Samuel Abiven, and Michael W.I. Schmidt

University of Zurich, Physical geography, Department of Geography, Zürich city, Switzerland (nimisha.nimisha@geo.uzh.ch, 0041446356841)

Future climatic changes might result in an increased potential for wildfires, whereby incorporation of charred biomass into soil would increase. The incomplete combustion of biomass results in the production of a chemically heterogeneous class of highly condensed compounds known as pyrogenic C (PyC), which is generally considered resistant to microbial degradation. Recently, studies based on short-term laboratory incubations with soil have indicated that PyC can also eventually degrade (Baldock and Smernik, 2002; Hamer et al., 2004) and it is now widely accepted that a significant quantity of these resistant fraction of soil must have undergone degradation in terrestrial environments. Charcoal has been shown to decompose faster in the initial stages (first 2-3 months) and stabilize later (Kuzyakov et al., 2009). However, studies describing charcoal transformation processes remain scarce. The different potential degradation mechanisms have not yet been studied in combination, and therefore the relative importance for PyC degradation has not been evaluated.

We are conducting an incubation experiment to study the biological, chemical and physical degradation/stabilization processes of PyC in soil under controlled conditions. We use Pinus ponderosa 13C/15N labeled (13C: 800 per mil, 15N: 4.2 atom %) wood and charcoal (pyrolysed at 450 °C under N2 atmosphere). We incubate soil from Lägeren forest (Wettingen, Switzerland) with three kind of organic inputs, labeled wood, char and no littler control. The decomposition rates would be estimated based on 13C of CO2 entrapped in NaOH. Time course destructive sampling would be done during the study. Lyophilized soil subsamples will be used for analysis of the amount of 13C incorporation in the microbial biomass using fumigation extraction method and phospholipids fatty acid analysis (PLFA). The remaining PyC in the soil would be characterized for the changes in its chemistry at the molecular level using Benzenepolycarboxlic acid (BPCA) molecular marker method and 13C 15N NMR.

This communication aims to report the first four months results of this study at a higher time resolution. The outcome of this study would facilitate in elucidating the potential decomposition rate of charcoal and consequent changes in its physical, chemical and biological properties in the soil during the initial stages of decomposition. In addition, application of highly labeled 13C PyC would enable us in this study to trace the transformation products.

References

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