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Measuring decomposition to understand stabilisation: A journey to Serendip? The example of root derived and pyrogenic organic matter dynamics in soils

S. Abiven
University of Zurich, Switzerland (samuel.abiven@geo.uzh.ch)

Soils store one of the largest organic carbon reservoirs of terrestrial ecosystems and any change in this carbon stock can significantly modify climate on the global scale. The mechanisms of this carbon stabilisation in soils are still not well known, difficult to define and, as a consequence, difficult to assess by measurement or by modelling. One method often chosen to access stabilisation processes is to measure decomposition of fresh organic inputs, with the underlying hypothesis that what did not left the soil profile should be stabilized for a certain duration in the soils. This approach is often associated with a deterministic view of organic compounds behaviour in soils, i.e. some compounds are more recalcitrant than others, and so the chemical compounds of the initial organic inputs should determine the stability of organic matter in the soils.
Decomposition studies are often favoured because the initial conditions can be well characterised or controlled, while studies based on archive samples could be limited by the knowledge of the edaphic conditions.

Recent findings challenge this decomposition approach: it has been shown that specific compounds tend to turnover more or less at the same speed in the soil, "recalcitrant" carbon is not always associated with the oldest ages... Recently, Schmidt et al. (2011) propose that persistence of organic matter is an ecosystem property and that environmental and biological controls dominate. In the frame of this new conceptual approach, the authors are also recommending a new generation of experiments.

What could be these new experiments? How to design new decomposition experiments in order to better assess carbon stabilisation in soils? Is there serendipity to be found in decomposition studies, i.e. can we expect relevant new outcomes from controlled conditions studies?

In this contribution, I will propose some thoughts regarding these questions, based on examples related to two promising long-lasting carbon inputs to the soil, the root derived and the pyrogenic organic matter.

Schmidt, M. W. I., Torn, M. S., Abiven, S., Dittmar, T., Guggenberger, G., Janssens, I. A., Kleber, M., Kögel-Knabner, I., Lehmann, J., Manning, D. A. C., and others, 2011. Persistence of soil organic matter as an ecosystem property. Nature 478, 49–56.