Biogeosciences Discuss., 3, S186–S189, 2006
www.biogeosciences-discuss.net/3/S186/2006/


Biogeosciences
Discussions



# *Interactive comment on* "Thermal stability of soil organic matter responds to long-term fertilization practices" *by* J. Leifeld et al.

**J. Leifeld et al.**

Received and published: 16 May 2006

Reviewer 1

Title. We adopted the suggestion to change the title to 'Thermal stability responses of soil organic matter to long-term fertilisation practices'.

Measuring bulk soil instead of clay fractions. We added the sentences: 'Unlike soil fractions, the analysis of bulk soils requires no time-consumptive sample pre-treatment and has been applied previously (e.g. Satoh, 1984). However, because organic matter in soil fractions is often more sensitive to land-use or management than bulk SOM, it is still uncertain whether management effects are systematically reflected in the thermal behaviour of bulk SOM'. We also changed the subsequent sentence to: 'Thermal properties of bulk soils from controlled long-term arable treatments under different fertilization regime are appropriate to check for systematic effects but to our knowledge have not been investigated so far.'

Abbreviations. We considered to use longer ones but retained the current ones because they are logical. The abbreviations are real acronyms where N stands for Null, M stands for manure, and the order (NM, MN) stands for the direction of change.

Wood and wood char. The thermal properties of wood and wood char are beyond the scope of this paper. It is also very unlikely, that wood plays a major role in this long-term agricultural experiment.

Sampling technique. We added the sentence: 'We chose the latter approach to distinguish long-term treatment effects from short-term noise induced by varying amounts of plant residues in the soil throughout the year.' The sampling depth of 0-20 cm matches the ploughing depth. All treatments are ploughed in the same way, so stratification within the soils' profile is not to be expected.

Thermal properties. This is a helpful suggestion. We re-formulated the sentence to:' Though their OC content was the same, treatment effects between MN and NM could be clearly distinguished by peak heights of the second peak and by the ratio peak height peak one / peak height peak two (Fig. 4), implying a higher sensitivity of SOM quality than of OC content to fertilization'.

Sentence page 314, line 12-16. Suggested changes were adopted.

Technical corrections were adopted apart from giving ranges for peak temperatures. Individual temperatures are important for comparison to other studies.

Reviewer 2

Introduction, page 311, bulk soils. The first reviewer, see comments there, has raised this topic also. We included also the reference (Satoh, 1984).

Dependence between DSC peak height and C content. As requested, we included



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the statistical results for the three single peak regions at the beginning of the results section and added the reference Siewert (2004) for comparison. The results show, that the first and second exotherm correlate highly significantly with the OC content, while the third peak does not. To remain consistent, we had to change the order of topics at the beginning of the discussion section. We still start with the OC contents, and insert the section describing the shape of thermograms behind it before discussing correlations between peak heights and OC contents.

Peak intensities in the stable fraction / at higher temperatures and interference with clay minerals. The reviewer is right and we have measured several clay minerals (kaolinite, smectite, illite) to identifiy endothermic peak positions. We therefore added the sentences: 'Because some clay minerals, kaolinite in particular, undergo dehydroxylation in that temperature region (e.g. Kakali et al., 2001), the observed exotherm at 520 °C may be attenuated by endothermic reactions from clay mineral decomposition. Infrared spectra from all samples revealed similar absorbance at 3695 cm-1 attributable to kaolinite (not shown), thus suggesting comparable amounts of that mineral. In addition, we do not expect strong variations in the clay mineralogy and thus no treatment-specific effect because of the comparable small field size and the homogeneous parent material.'

Contribution of artificial char from plant materials in soil. The reviewer mentions the possible contribution of charring to the formation of thermally stable material. We do not think that charring of plant materials during DSC heating forms material that is stable $>$ 500°C. We added the following sentences to the discussion: 'The third peak is not typical for the oxidation of natural organic matter (see e.g. Dell'Abate et al., 2003, Shafizadeh, 1984), but charring during the experiment may form thermally stable compounds (Kaloustian et al., 2001). However, charring of cellulose and lignin, the main constituents of vascular plants, resulted in peaks much below 500°C when normalized to the same heating rate (Shafizadeh, 1984; Kaloustian et al., 2001). Together with our finding that the third peak was not correlated to the OC content of the samples, we act on the assumption that this peak is attributable to compounds already in the soil.'

Technical corrections:

1) Mineral fertilisation. We added 'annual' before 'mineral fertilization' to the corresponding sentence in the material and methods.

2) Reference Shafizadeh: corrected.

New References added:

Satoh, T.: Organo-mineral complex status in soils. I. Thermal analytical characteristics of humus in the soils. Soil Sci. Plant Nutr., 30, 1-12, 1984

Siewert, C.: Rapid screening of soil properties using Thermogravimetry. Soil Sci. Soc. Am. J. 68, 1656-1661, 2004.

Kakali, G., Perraki, T., Tsivilis, S., and Badogiannis, E.: Thermal treatment of kaolin: the effect of mineralogy on the pozzolanic activity. Appl. Clay Sci., 20, 73-80, 2001.

Kaloustian, J., Pauli, A. M., and Pastor, J. Kinetic study of the thermal decompositions of biopolymers extracted from various plants. J. Therm. Anal. Calorim., 63, 7-20, 2001.

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Interactive comment on Biogeosciences Discuss., 3, 309, 2006.