THERMAL ANALYSIS OF NATIVE AND CULTIVATED SOILS AFTER LONG-TERM INCUBATION

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INTRODUCTION

Thermal analysis techniques have been typically used for the identification and quantification of soil mineral constituents, but their use has recently gained increasing importance in the study of soil organic matter (SOM) and has been proposed as a relatively rapid and low-cost option for characterizing organic matter stability. However, the number of tested soils and fractions are not yet large enough and additional experiments must be performed to demonstrate the potential link between thermal and biological SOM stability.

MATERIALS & METHODS

In a previous study, four different soil surface samples (Indian Head - SK; Mandan - ND; Akron - CO; and Waggoner Ranch - TX), each with a native and cultivated land use, were collected and incubated at 35°C for 588 days and CO_2 measurements were taken periodically. Cumulative respiration data, together with original C contents are reported in Table 1. In the current study, a STA 409 PC Netzsch thermal analyzer was used to perform different scanning calorimetry (DSC) analysis (10 °C/min heating rate; Pt-Rh crucible and 30 mL min^{-1} synthetic air atmosphere) for all the samples before and after incubation.

RESULTS & DISCUSSION

Soil C concentrations and proportions of mineralizable C differed significantly among the four sites and land use treatments (Table 1). As expected, soil C concentrations and levels of mineralized C were higher for native than for cultivated soils due to high microbial oxidation consequence of tillage. As reflected by DSC thermograms in Figure 1, the exothermic reactions associated with the thermal oxidation of the organic matter were characteristic for each soil analyzed matching higher energy levels with higher soil C contents (Table 1).

Table 1: C contents (%), cumulative respiration levels (µg C/g soil C) and energy differences (J g^{-1}) at the specified temperature intervals between values measured before and after incubation for all the soils analyzed.

Site	Soil Taxonomy	Land Use	Total C (%)	Cumulative resp. (µg C g soil C^{-1})	ΔEnergy 200-420°C (J g^{-1})	ΔEnergy 420-600°C (J g^{-1})
SK	Udic Boroll	Native	3.31±0.05	4407.2	141.1	48.9
		Cultivated	2.10±0.08	727.2	57.5	14.4
ND	Typic Argiborroll	Native	2.81±0.03	5674.3	144.2	38.6
		Cultivated	2.38±0.11	2228.1	77.9	-1.7
CO	Aridic Paleustoll	Native	1.20±0.02	2520.8	73.1	17.1
		Cultivated	0.68±0.00	979.0	16.1	0.0
TX	Typic Paleustoll	Native	0.82±0.03	2092.2	64.4	12.7
		Cultivated	0.71±0.03	1887.4	35.5	3.3

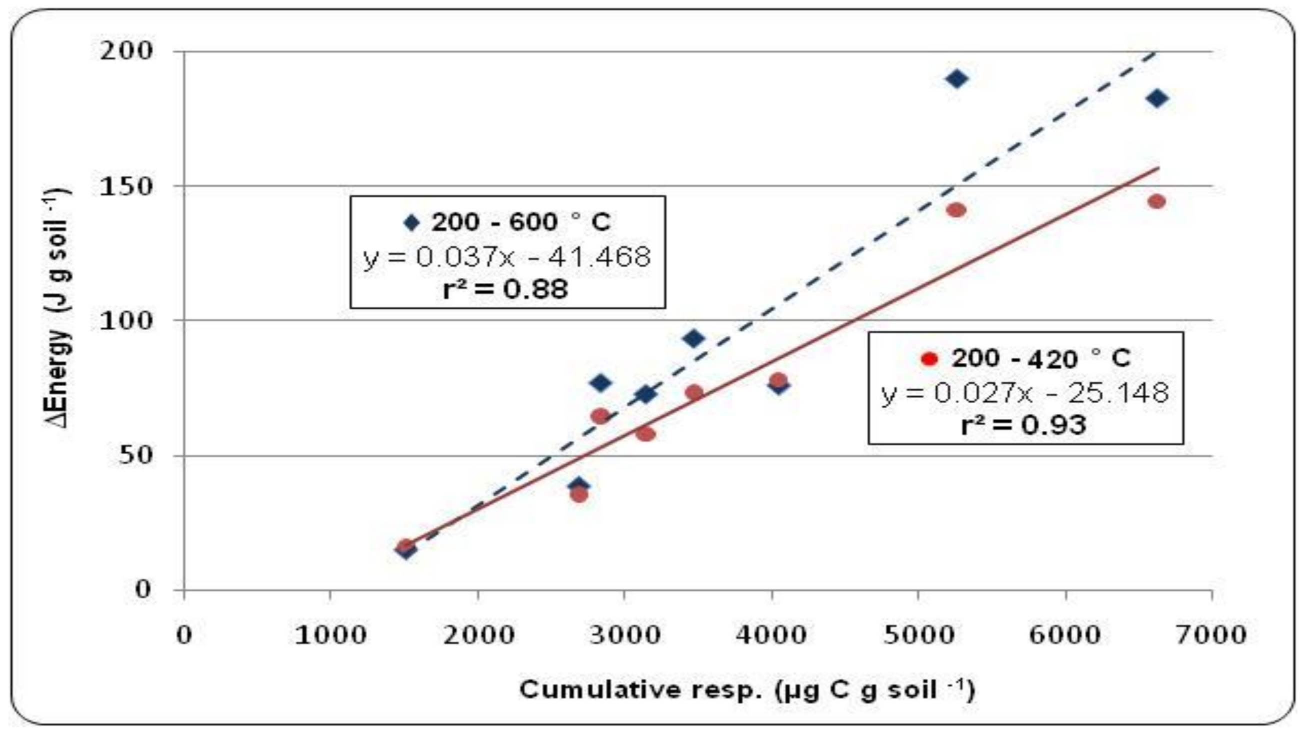

Figure 2: Relationship between cumulative respiration values and total energy changes before and after incubation.

Comparison of DSC results before and after incubation by curve subtraction suggests that incubation depleted mainly thermally labile (< 420° C) rather than more stable (> 420° C) material . The integration of DSC curves and subtraction of the results obtained allow the calculation of total energy losses associated with the incubation process. These energy losses are strongly correlated **(r^2=0.88)** with C losses due to mineralization of SOM during incubation (Fig 2). This relationship is even stronger **(r^2=0.93)** with the fraction of energy loss associated with the most thermally labile material (< 420° C).

CONCLUSIONS

Thermal analysis results are characteristic for each soil and are strongly correlated with the variations in C contents detected in the samples. These results provide more evidence about the existence of a link between biological and thermal stability, pointing for the use of thermal analysis to rapidly characterize SOM quantity and changes in SOM quality.

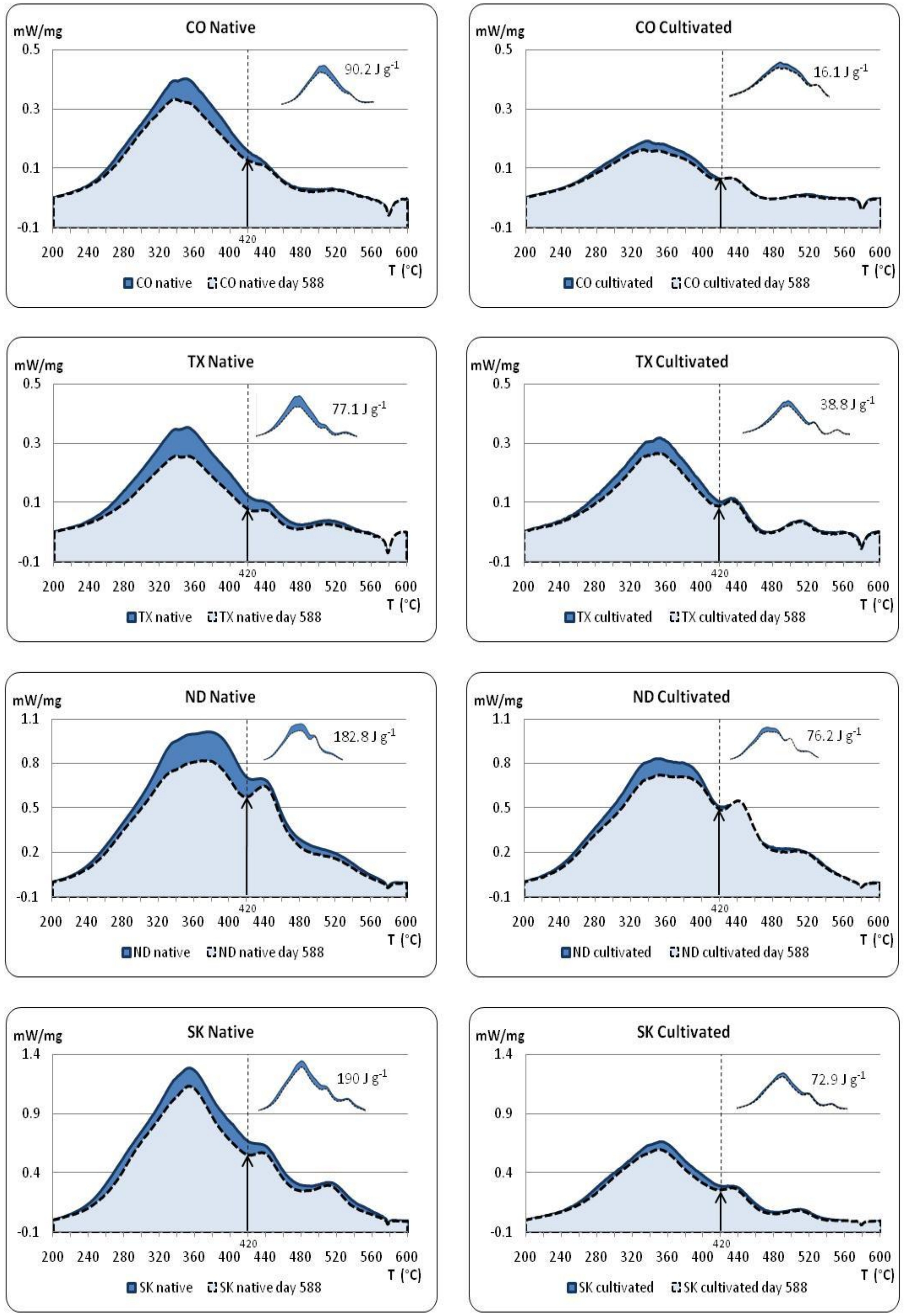

Figure 1: DSC thermograms for native and cultivated soils analyzed before and after 588 days under incubation