

## Thermal analysis of organo-mineral complexes with increasing carbon loadings

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Thermal analysis techniques (i. e., thermogravimetry (TG) and differential scanning calorimetry (DSC)) have recently been proposed as rapid methods to assess the quality continuum of soil organic matter. An experiment was designed to test the hypothesis that the energy density ( $\text{J mg}^{-1}$  OM) of organo-mineral complexes changes as carbon loading ( $\text{mg C m}^{-2}$  mineral surface area) increases.

### Methods

Surface soil samples were collected from a long-term manure addition experiment located at Lethbridge, AB Canada. Soils were dispersed and sieved to isolate a fraction consisting of silt- and clay-sized organo-mineral complexes. Total organic carbon concentrations and mineral specific surface area were determined, and used to calculate carbon loading ( $\text{mg C m}^{-2}$ ).

Using a Netzch instrument, organo-mineral complexes were heated from 25 to 700 °C at a rate of 10 °C  $\text{min}^{-1}$ . Energy content of the organic matter was determined using the area of the DSC peak in the exothermic region (180-600 °C). Energy density ( $\text{J mg}^{-1}$  OM) was calculated by dividing the energy content (J) by TG mass loss (mg) over the same temperature range.

Manure addition rate ( $\text{Mg ha}^{-1} \text{ yr}^{-1}$ )	Carbon loading ( $\text{mg C m}^{-2}$ )	Energy Density ( $\text{mg C m}^{-2}$ )
0	$1.29 \pm 0.47$	$9.52 \pm 0.53$
60	$2.47 \pm 0.22$	$14.57 \pm 0.35$
120	$3.48 \pm 0.65$	$15.48 \pm 0.01$
180	$7.46 \pm 1.39$	$16.04 \pm 0.09$

**Table 1:** Carbon loadings and energy densities of organo-mineral complexes.

### Discussion of Results

Results indicate that increasing manure addition rates increased carbon loadings of organo-mineral complexes. Thermal analyses show that energy density was correlated with carbon loading, suggesting that decomposability may increase as soils approach their protective capacity.

## The role nanoparticulate oxides as transporters of toxic trace metals in riverbed sediment

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Nanoparticulate oxides from a mining-contaminated river system were examined to determine their role as transporters of toxic trace metals. A recent dam removal project on the Clark Fork River in western Montana (USA) has released upstream sediment contaminated with toxic trace metals (Pb, As, Cu and Zn) which resulted from a century and a half of upstream mining activity. Density separation with sodium polytungstate ( $2.8\text{g/cm}^3$ ) was used to separate the low and high density particle fractions of riverbed sediment. An aqueous extraction method was then applied to the high density fraction to retrieve the nanoparticulate fraction and this was then analyzed by analytical transmission electron microscopy (aTEM) and flow field-flow fractionation (FIFFF) coupled to both multi angle laser light scattering (MALLS) and high resolution – inductively coupled plasma mass spectroscopy (HR-ICPMS). FFF analysis revealed a size distribution in the nano range and that the elution profiles of the trace metals matched most closely to that for Fe and Ti. aTEM confirmed these results as the majority of the particles and particle aggregates analyzed were Fe and Ti oxides and were associated with one or more of the trace metals of interest. The most common mineral nanophases hosting metals were goethite, ferrihydrite and brookite. As nanoparticles are known to have altered properties relative to bulk mineral phases, and are also capable of extended transport, this suggests that they are likely playing a key role in determining the movement, distribution, and bioavailability of contaminant trace metals.