Geophysical Research Abstracts
Vol. 12, EGU2010-3779, 2010
EGU General Assembly 2010

Simplified method to assess soil organic matter in landscape and carbon sequestration studies

Robert Pallasser (1), Budiman Minasny (1), Alex McBratney (1), and Hank De Bruyn (2)

(1) Faculty of Agriculture, Food and Natural Resources, University of Sydney, Australia, (r.pallasser@usyd.edu.au), (2) School of Chemistry, University of Sydney, Australia

Soil organic matter (SOM) is composed of a variety of carbon bearing forms which are variably susceptible to degradation, itself a function of soil conditions (moisture, permeability, pH, Eh). Stability and residence time have become key questions relevant to soil carbon storage. Interestingly, organic matter types also differ in terms of their refractory stabilities making thermal analysis potentially an ideal way to resolve and analyse SOM.

Elemental analyses of soils are routinely used to provide accurate total carbon determinations for the sub-samples in question but cannot yield information about the relative amounts of labile to more stable carbon without involved chemical pre-treatment. Thermogravimetric analyses (TGA) have been commonly used to characterise chemical decomposition and to provide distinctive fingerprints (due to discrete mass changes) for mineral and organic materials. Such discrete changes in mass appear as peaks when registered on a DTGA (differential TGA) plot and correspond with dehydration, denaturing or oxidation events. Soil being a more complex continuum of organic and inorganic substances, many from fermentation reactions and microbial waste, does not have one particular fingerprint. Nonetheless, a number of relevant organic substances have characteristically different but consistent ignition temperatures (Lopez-Capel et. al., 2006; Laird et al., 2008; Xie et. al., 2009) allowing carbon pools to be distinguished thermally.

In our studies, oxidative DTGA analyses of soils using a TA 2590 were typified by a bimodal distribution in SOM representing one less stable and one more stable group, a pattern similarly described by Siewert (2004). Current experiments indicate that the relative proportions of these SOM pulses are fairly reproducible but vary depending on soils and sampling depth (i.e. conditions) enabling it as a diagnostic parameter when considering SOM dynamics and humification. In order to compare this property numerically, relative DTGA responses were quantified in a similar way to the approaches discussed by Plante et. al., (2009) and references therein. TGA-MS analyses were conducted using a TA SDT Q 600 – Thermostar quadrupole, so as to provide a distinctive set of major ions or markers for the two organic matter types which can be indicative of the parent material. Furthermore, since a mass change event from an inorganic component (e.g. dehydroxylation) can contribute to an SOM related response, correlation with MS data needed to be carried out.

This method of analysis can be used to reliably fingerprint SOM and should be an enormously useful addition when assessing depositional or agricultural soil environments. Quantifying the relative amounts of SOM can be achieved by coupling with elemental analysis with the added scope of being able to separate (Kasozi et. al., 2009) the contribution from inorganic carbon (carbonates), a common soil constituent. Important applications for the DTGA technique include environmental pedological studies such as evaluating SOM after severe bushfire events or agricultural monitoring particularly during carbon sequestration and changed land management practices.
References

Kasozi G.N., Nkedi-Kizza P., Harris W.G., 2009. Varied carbon content of organic matter in histosols, spodosols and carbonatic soils. Soil Science Society of America Journal 73, 1313-1318.
Laird D.A., Chappell M.A., Martens D.A., Wershaw R.L., Thompson M., 2008 Distinguishing black carbon from biogenic humic substances in soil clay fractions. Geoderma 143, 115-122.
Lopez-Capel E., Abbott G.D., Thomas K.M., Manning D.A.C., 2006. Coupling of thermal analysis with

quadrupole mass spectrometry and isotope ratio mass spectrometry for simultaneous determination of evolved gases and their carbon isotopic composition. Journal of Analytical and Applied Pyrolysis, 75, 82-89.
Plante A.F., Fernandez J.M., Leifeld J., 2009. Application of thermal analysis techniques in soil science. Geoderma 153, Issue 1-2, 1-10.
Siewert C., 2004. Rapid screening of soil properties using thermogravimetry. Soil Science Society of America Journal 68, 1656–1661.
Xie X.F., Goodell B., Zhang D.J., Nagle D.C., Qian Y.H., Peterson M.L., Jellison J., 2009. Characterization of carbons derived from cellulose and lignin and their oxidative behaviour. Bioresource Technology 100, 1797-1802.