Determination of soil particulate organic matter in micro samples

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INTRODUCTION

Particulate organic matter (POM) enhances soil aggregate formation and stability while soil aggregates enhance POM accumulation which is an early indication of carbon sequestration in ecosystems. Quantitative characterization of the physical protection that is provided within soil aggregates to POM can be well understood with the application of X-ray computed tomography (CT), however; its application needs to be validated using conventional POM analysis.

OBJECTIVES

1. Evaluate performance of conventional method of POM determination for small soil sample.
2. Compare POM concentration determined from small (0.25 g) and large (25 g) samples using the loss on ignition approach.
3. Compare POM determination using conventional method and X-ray computed micro-topography (µCT) images.

MATERIALS AND METHODS

Conventional POM determination

- 25 g air dried samples in 100 ml of 5% sodium hexametaphosphate solution
- Shaking for 16 hr

The effect of the following procedural steps were tested using soil samples collected from conventional agriculture and native vegetation:

1) Sample pretreatment
   - Air-dry
   - Oven dry
   - Field moist
2) Shaking frequency
   - 60 rotations per minute
   - 200 rotations per minute
3) Soil to solution ratio
   - 1:4
   - 1:8
4) Sample size
   - 0.25 g
   - 25 g

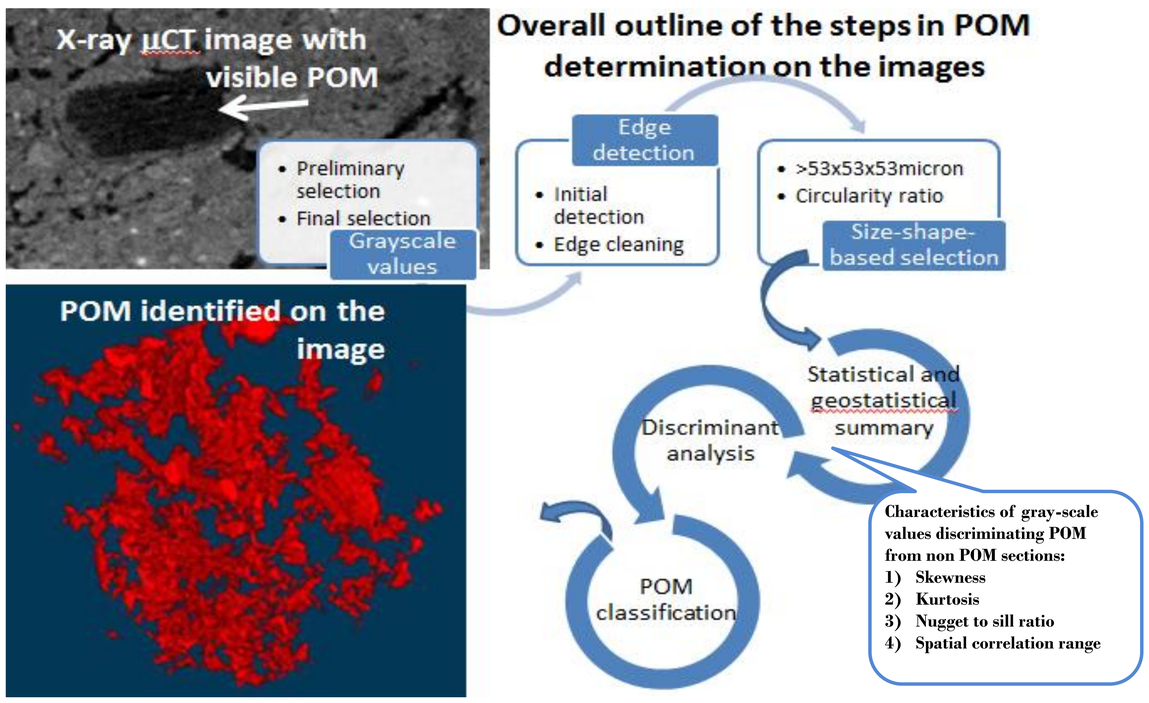


Fig. 1 Overall outline of the steps in POM determination on the images

Using X-ray µCT

Intact aggregates of 4 to 6 mm sieve sizes were scanned at the SIMBIOS Centre, University of Abertay Dundee using Metris X-Tek HMX microtomography system at 15 µm resolution. Preliminary POM identification consisted of a series of steps accounting for (Fig. 1):

1) Range of gray-scale values
2) Edge properties
3) Particle size and shape

The final POM identification was based on (Fig. 1)

4) Statistical characteristics of the gray-scale values
5) Discriminant analysis

RESULTS

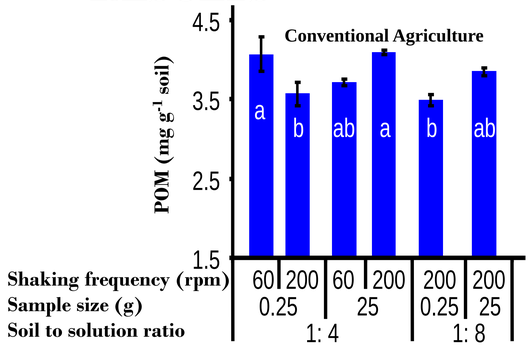
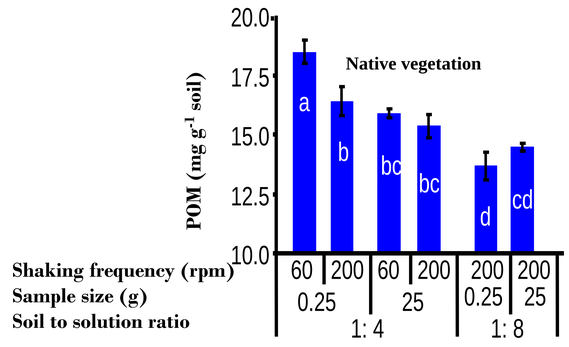
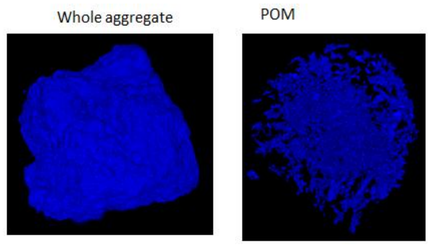


Fig. 2 shaking frequency, sample sizes and soil to solution ratio effect on POM concentration in conventional agriculture

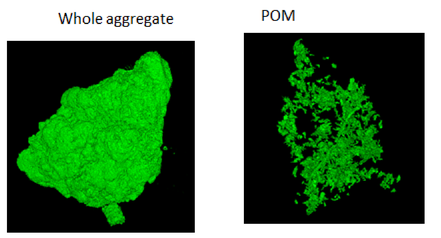


Columns followed by the different letters are significantly different from each other (p<0.05).

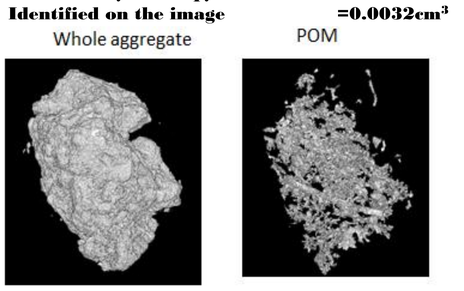
Fig. 3 shaking frequency, sample sizes and soil to solution ratio effect on POM concentration in native vegetation



POM
Measured by Micro-pycnometer =0.0024cm³
Identified on the image =0.0022cm³



POM
Measured by Micro-pycnometer =0.0019cm³
Identified on the image =0.0032cm³



POM
Measured by Micro-pycnometer =0.0005cm³
Identified on the image =0.0019cm³

Fig. 5 Images of the three studied aggregates and their identified POM.

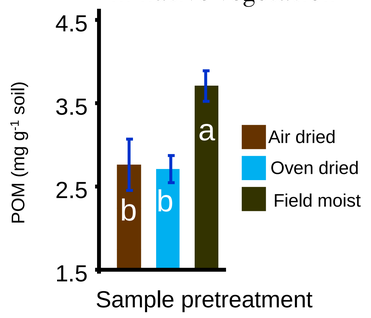


Fig 4. Effect of sample pretreatments on POM concentration

CONCLUSIONS

- Low shaking frequency significantly overestimated POM recovered from small samples in both soils of conventional agriculture and native vegetation, whereas 1: 8 soil to solution ratio declined POM determined from the latter. Therefore, 200 rpm and 1: 4 soil to solution ratio can be used for estimating POM concentration in small samples such as a single soil macro-aggregate of 0.25 g.
- Sample pretreatment such as air or oven drying can significantly underestimate POM concentration in disturbed samples. This effect needs to be studied further in soil types of different land use systems.
- X-ray µCT image analysis holds high potential for determination of POM in small soil samples, e.g., individual soil aggregates.

ACKNOWLEDGEMENTS:

This research was funded in parts by EPA-USDA program "Enhancing Ecosystem Services from Agricultural Lands", by NSF LTER Program at KBS, USDA-NIFA award No. 2011-68002-30190 cropping systems coordinated Agricultural Project (CAP). The authors would also like to thank Mel Erickson, Rich Price and Jonathan Dahl for their technical support.