Characterization of organic matter in density-size fractions of soil aggregates by DRIFT spectroscopy combined with sodium hypochlorite oxidation

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Introduction

Soil organic matter (OM) consists of particulate organic matter (POM) and mineral-associated organic matter (MAOM). POM undergoes microbial decomposition within aggregate structures and is transformed into MAOM of microbial origin. Microaggregates are formed by the binding action of microbial materials and further bound together into macroaggregates mainly due to the proliferation of microorganisms during the decomposition of POM. Thus, POM is present outside of the aggregates at first and gradually occluded within aggreagates as the decomposition proceeds. This indicates that the chemical nature of POM differs depending on inside and outside of the aggregate and on the size of aggregate. The density-size fractionation is suitable for investigating the forms and locations of the OM within aggregate structures.

The objective of this study was to characterize the relatively unstable OM in density-size fractions of macro- and microaggregates separated from two types of soils (Udifluvent and Melanudand). The relatively unstable OM was evaluated by sodium hypochlorite (NaClO) oxidation. The NaClO-oxidizable OM in density-size fractions were characterized by diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy combined with NaClO oxidation. The DRIFT spectra were obtained as the difference spectra by subtracting the spectra after NaClO oxidation (Aoyama 2016).

Marerials and methods

Soil samples used

Two soil samples were taken from the surface layer (0-15 cm) of upland fields at the University Farm of Hirosaki University.

- Fujisaki soil (Udifluvent): Total C 1.16%; Total N 0.12%; C/N ratio 10.0
- Bunkyo soil (Melanudand): Total C 8.73%; Total N 0.57%; C/N ratio 15.4

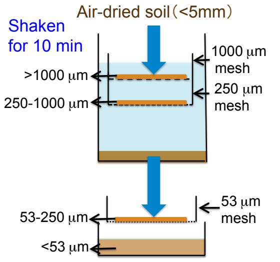

Fig. 1 Method for aggregate separation.

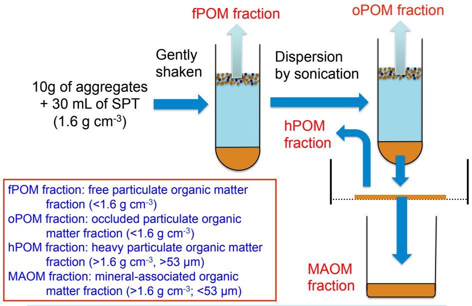

Fig. 2 Schematic diagram of density-size fractionation.

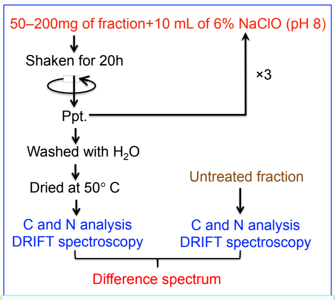

Fig. 3 Method for NaClO oxidation and the measurement of DRIFT spectra.

Results

- Most of the OM was present in the form of MAOM for all the aggregate size fraction (Figs. 5-7). The fPOM and oPOM were present primarily in the macroaggregates (Figs. 6 & 7).
- The proportion of C oxidized with NaClO was lower than that of N. Thus, the C/N ratio was lower in the NaClO-oxidized OM than in the NaClO-unoxidized OM (Fig. 8).
- The C/N ratio of NaClO-oxidized OM was relatively high in the fPOM and oPOM fractions and relatively low in the MAOM fraction.
- DRIFT spectroscopy revealed different OM characteristics in density-size fractions of aggregate size fractions (Figs. 9 & 10).

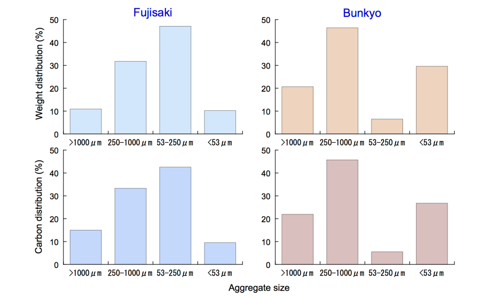

Fig. 4 Weight and carbon distributions among the aggregate size fraction.

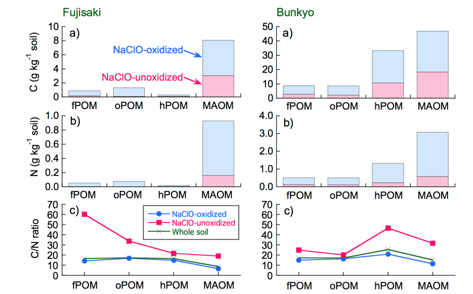

Fig. 5 Carbon, nitrogen and C/N ratio of density-size fractions of whole soils.

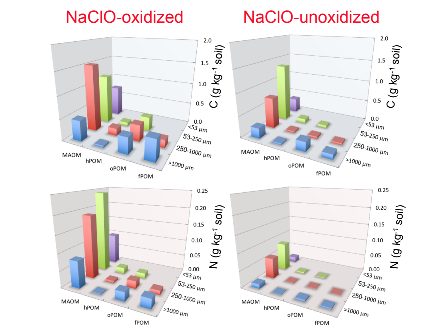

Fig. 6 Amounts of carbon and nitrogen in the density-size fractions of aggregates of the Fujisaki soil.

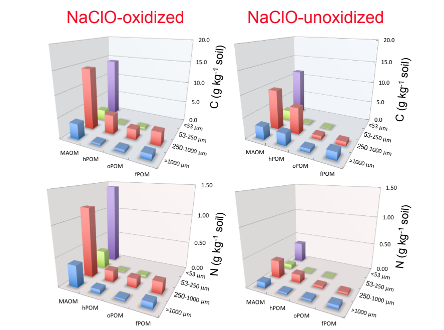

Fig. 7 Amounts of carbon and nitrogen in the density-size fractions of aggregates of the Bunkyo soil.

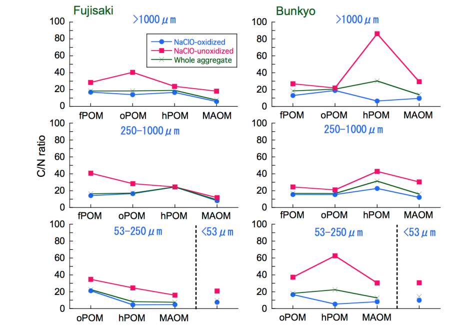

Fig. 8 C/N ratio of NaClO-oxidized and -unoxidized OM in the density-size fractions of aggregates.

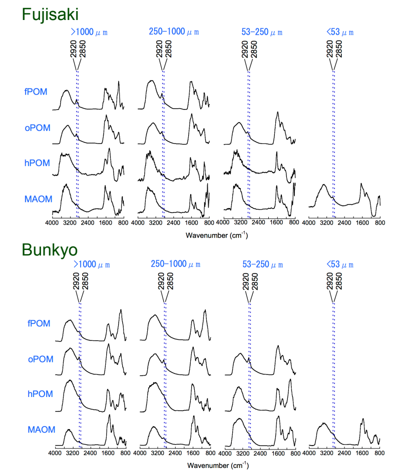

Fig. 9 DRIFT spectra of NaClO-oxidized OM in the density-size fractions of soil aggregates.

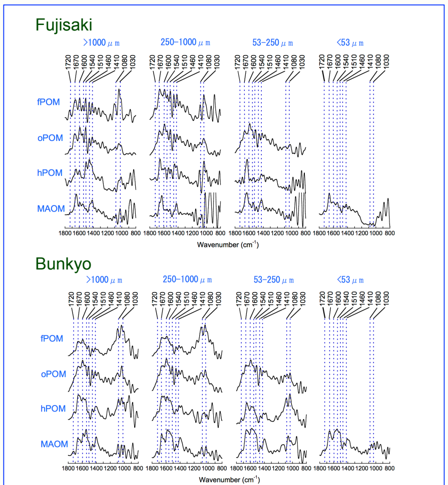

Fig. 10. Deconvoluted spectra of NaClO-oxidized OM in the density-size fractions of soil aggregates.

Conclusions

- Fractionation of OM in different size of aggregates based on density and particle size successfully separated the soil OM into the fractions with different chemical nature.
- NaClO oxidation separated the OM fractions into the relatively unstable and stable fractions. The former fraction had lower C/N ratio than the latter fraction. This was attributed to the fact that the NaClO-unoxidized OM consisted mainly of charred materials.
- DRIFT spectroscopy combined with NaClO oxidation was effective to characterize the chemical nature of the density-size fractions of aggregates.
- Further separation is required to characterize the soil OM in more detail.

Reference

Aoyama, M. 2016: DRIFT spectroscopy combined with sodium hypochlorite oxidation reveals different organic matter characteristics in density-size fractions of organically managed soils. *Can. J. Soil Sci.*, **96** (3), 317–327, 10.1139/cjss-2015-0076.