

Soil organic matter and aggregate hierarchy revisited: a case study using an Andisol

WAGAI, Rota^{1*}; ASANO, Maki²; KAJIURA, Masako¹; INOUE, Yudzuru³; HAYAKAWA, Chie⁴; HIRADATE, Syuntaro¹

¹National Institute of Agro-Environmental Science, ²University of Tsukuba, Graduate School of Life & Environmental Sciences, ³Saitama University, Graduate School of Science and Engineering, ⁴The University of Tokyo, Graduate School of Agricultural and Life Sciences

Soil aggregate structure is likely to exert fundamental control on soil biology (e.g., microbial activity and community composition) and soil biogeochemistry including the stabilization and mobilization of soil organic matter (SOM). Aggregate hierarchy concept (Tidall and Oades, 1982) has been verified for most temperate and tropical soil types except for Andisols developed from tephra and volcanic rocks are known for strong aggregate stability and high SOM storage capacity. We recently showed the first evidence of hierarchical structure in Andisol (Asano and Wagai, 2013). After maximum dispersion (achieved only after 5 kJ/mL sonication following sodium saturation), most of macro- and micro-aggregates were broken down to much smaller particles (<0.2 and 0.2-2 μm) that accounted for dominant proportion of total C, N, and extractable phases of Al, Si, and Fe. These <2 μm particle-size fractions appeared to act as persistent binding agent, contributing to the high physical stability of the aggregates. When the same soil was fractionated by density, the aggregates resistant to mechanical shaking (i.e. higher level in hierarchical structure) showed progressive changes in chemistry along density gradient (Wagai et al. 2014). Among the intermediate density fractions (2.0-2.5 g/cc) where >80% of total C and N and the extractable metals are present, we found general decrease in C:N ratio and $\delta^{14}\text{C}$ and concurrent enrichment of ^{13}C and ^{15}N in accord with previous reports.

The next key question is how the particle-size fractions isolatable after the maximum dispersion are assembled together to form the shaking-resistant aggregates of different density. We attempted to answer this question by examining the organic and inorganic chemistry (C, N, ^{13}C , ^{15}N , $\delta^{14}\text{C}$, ^{13}C -NMR, extractable metals) and the surface characteristics (SSA by N_2 -BET and XPS) of the size and density fractions. We will also discuss the nature of organo-mineral interactions inferred from our results and compare it with the previously-suggested concepts such as aggregate hierarchy (Tidall and Oades, 1982), and "zonal layering" model (Kleber et al. 2007).

References:

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