Geophysical Research Abstracts
Vol. 21, EGU2019-6348, 2019
EGU General Assembly 2019

Association between soil organic carbon and soil particles and its consequences for soil structure and solute transport

Jumpei Fukumasu (1), Christopher Poeplau (2), Thomas Kätterer (3), Elsa Coucheney (1), John Koestel (1), Nick Jarvis (1), and Mats Larsbo (1)

(1) Swedish University of Agricultural Sciences, Department of Soil and Environment, Uppsala, Sweden (jumpei.fukumasu@slu.se), (2) Thuenen Institute of Climate-Smart Agriculture, Braunschweig, Germany, (3) Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, Sweden

Organic carbon is a key component in soil, which influences important soil physical properties such as soil structure. It has been hypothesized that an association between clay and soil organic carbon (SOC) can increase soil porosity and structural stability. This association can also enhance the storage of SOC itself through physico-chemical stabilization. If SOC has an impact on soil structure, SOC should also influence water flow and solute transport in soil; however, the knowledge regarding SOC effect on these soil physical processes is still limited. The purpose of this research was (1) to quantify the amount of stable SOC associated with silt and clay and (2) to reveal how total SOC and the stable SOC fraction influence soil structure and preferential transport.

We sampled two different sizes of undisturbed soil cores (n=35) from a conventionally tilled arable field with large variation in clay (9–45%) and total SOC (1.1–2.7%) contents. Large cores (height 200 mm, diameter 125 mm) were used to quantify the degree of preferential transport by conducting non-reactive solute transport experiments and to analyze macropore networks (pores > 0.12 mm) using X-ray tomography. The small cores (100 mm height, 68 mm diameter) were used to determine soil water retention at -30, -100, -300 and -600 cm pressure potential and thus pore volumes corresponding to these pressure potentials. Additionally, we conducted SOC fractionation to obtain the SOC fraction associated with clay and silt sized particles (< 0.063 mm).

On average, about 81.7% of total SOC was found in the clay and silt fraction. Regression analysis showed that the degree of preferential transport was positively correlated to the clay content ($R2 = 0.56$, $p < 0.0001$) whereas it was negatively correlated to the SOC content ($R2 = 0.11$, $p = 0.0335$). The mesoporosity (0.03–0.1 mm) was also negatively correlated to the degree of preferential transport ($R2 = 0.55$, $p < 0.0001$), suggesting that increased mesoporosity prevents the activation of macropore flow. A negative correlation between SOC and clay content makes it difficult to isolate effects of SOC on the degree of preferential transport. Therefore, we analyzed a subgroup (n=19) of the data in which there was no correlation between SOC (1.1–2.7%) and clay (16–29%) content. For this dataset, there were no significant correlations between the degree of preferential transport and clay ($p = 0.0916$) or SOC ($p = 0.1945$) contents. Instead, the SOC content in the silt and clay fraction was negatively correlated with the degree of preferential transport ($R2 = 0.26$, $p = 0.0146$), suggesting that a higher degree of association between clay + silt and SOC reduced the degree of preferential transport. The SOC concentration in the silt and clay fraction was also positively correlated with mesoporosity ($R2 = 0.73$, $p < 0.0001$). Overall, our preliminary results indicate that, although the clay content has a strong effect on the degree of preferential transport in this field, SOC reduces preferential transport through its effect on soil structure, particularly the existence of better-developed networks of mesopores.