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Effects of organic carbon fractions on soil structure and solute transport characteristics

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Soil organic carbon (SOC) plays an important role in the formation of soil structure. It has been hypothesized that the fraction of SOC complexed with clay is related to soil physical properties such as soil pore structure and bulk density. When the ratio between SOC and clay is larger than 0.1, the soil is "saturated" with carbon. Literature data indicate that the degree of preferential transport is negatively correlated with the SOC content for values below carbon saturation, suggesting a potential benefit of carbon sequestration for preventing groundwater contamination. However, it is not clear how generally applicable these findings are for agricultural soils which are affected by tillage and have relatively low carbon content. The objective of this study is to examine how SOC fraction is related to soil structure and solute transport characteristics in a tilled arable field with a natural variation in SOC (0.65-2.75 %) and clay (9-45%) contents.

We sampled undisturbed large (height 200 mm, inner diameter 125 mm) and small (100 mm height, 68 mm diameter) soil cores at 35 locations in the field covering the variation in SOC and clay contents. The large soil samples were used to analyze macropore (>0.2 mm pore size) networks using X-ray tomography, the normalized 5% arrival times of non-reactive tracer and unsaturated hydraulic conductivity at 0.1 and 1 kPa using disc infiltrometers. Additionally, we will conduct SOC fractionation to quantify SOC fractions with distinct functional properties. The undisturbed small cores will be used to determine soil water retention.

Preliminary results from solute transport experiments show a large effect of soil texture on the normalized 5% arrival times. Our results also indicate that large values of SOC reduce the degree of preferential transport (i.e. results in large 5% arrival times). In the near future, we are planning to analyze how the degree of carbon saturation and different SOC fractions affect macropore network properties and water retention. Then, effects of the structure characteristics on hydraulic properties and solute transport characteristics will be investigated. By clarifying the relationship between the degree of carbon saturation, macropore network characteristics and solute transport mechanism behind impacts of SOC on preferential flow will be revealed.