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Flow Cell Sampling Technique: A new approach to analyze physical soil and particle surface properties of undisturbed soil samples

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During unsaturated water conditions, water flow occurs in the soil mainly by water film flow and depends on moisture content and pore surface properties. More attention is attributed to coatings enclosing soil particles and thus may affect wetting properties as well as hydraulic soil functions. Particle coatings are most likely responsible for many adsorption processes and are expected to favor local heterogeneous microstructure with enhanced biological activity. Many of the effects described cannot be detected on the basis of conventional soil column experiments, which were usually made to study soil hydraulic processes or surface – soil solution exchange processes. The general objective of this study was to develop a new field sampling method to unravel heterogeneous flow processes on small scales in an undisturbed soil under controlled lab conditions. This will be done by using modified flow cells (Plexiglas). Beside the measurements within a flow cell as breakthrough curves, the developed technique has several additional advantages in contrast to common columns or existing flow chamber/cell designs. The direct modification from the sampling frame to the flow cell provides the advantage to combine several analyses. The new technique enables to cut up to 5 thin undisturbed soil slices (quasi-replicates) down to 10 and/or 5 mm. Relative large particles, for instance, may limit this sampling method. The large observation area of up to 150 cm2 allows the characterization of particle surface properties in a high spatial resolution within an undisturbed soil sample. This sampling technique, as shown in our study, has the opportunity to link soil wetting hydraulic and several particle surface properties to spatial soil heterogeneities. This was shown with tracer experiments, small-scale contact angle measurements and analyses of the spatial distribution of functional groups of soil organic matter via DRIFT mapping.