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Determining wetting soil-water characteristic curves for volcanic ash soil as affected by water repellency

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Soil-water hysteresis between wetting and drying phases, a characteristic of wettable soils but more pronounced in water repellent ones, is considered as a phenomenon that influences fingering flow and wetting front instability during infiltration. Measurement of wetting process of water repellent soil is tedious due to hindrance of capillary suction relationship as opposed to readily wettable soils. This lead to considerable variations in soil-water content during infiltration in an initially water repellent soil such that zones of very dry soil can be directly adjacent to zones of wet soil. Thus, the measurement techniques should be capable of obtaining precise and continuous measurement of soil-water content and metric potential in order to examine the hydraulic properties of water repellent soils. In this study, we first characterized the water repellency by Molarity of an Ethanol Droplet (MED) test and Water Drop Penetration Time (WDPT) of a volcanic ash soil obtained from the surface soil layer of a forested hill slope in Fukushima, Japan. Results showed WR in the volcanic ash soil could be categorized into several water repellency classes, and that the soil-water potential and soil organic carbon content are two key parameters in controlling the severity of water repellency. Secondly, we developed an experimental setup equipped with a mini Tensiometer-Time Domain Reflectometry (T-TDR) coil-probe that was capable of simultaneous and continuous reading of soil-water content and metric potential in a small pocket of soil. The T-TDR coil-probe was celebrated against the volcanic ash soil prior to steady upward infiltration tests. The experiment was carried out for several wetting and subsequent drying cycles by using soils with different degrees of repellencies. The results implied that; the wetting of water repellent soil is considerably slower than wettable soils, and water entry in term of soil-water potential is positive in water repellent soils in comparison to wettable soil for which less hysteresis phenomena can be shown.

Keywords: Aggregates, Fingering flow, Soil-water repellency, TDR-coil probe, Volcanic ash soil, Wetting curves