Geophysical Research Abstracts, Vol. 7, 03101, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03101

Soil water repellency effects on water retention in aggregated soils

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Soil water repellency greatly affects soil hydrological problems such as reduced water infiltration, enhanced surface runoff and erosion, and the forming of preferential flow patterns and fingering flow in soils. Although soil organic matter may cause both soil aggregation and a hydrophobic-material-coating of aggregates in organic-rich surface soils, the physics and water flow in water repellent aggregated soils are not fully understood.

In order to understand the soil physical properties of water repellent aggregated soils, volcanic ash soil materials were collected from seven different depth intervals with varying organic matter contents of between 0.7 and 19.8 %. Firstly, we characterized the degree of water repellency (WR) using the water drop penetration time (WDPT) test, and the effect of organic matter content and soil water content on water repellency was examined. Secondly, we determined the drying and wetting processes of the soil water characteristic curve (SWC) including several scanning curves (re-drying and re-wetting), using an experimental set-up composed of a small-scale time domain reflectometry coil probe (Nissen et al., 1998) and a tensiometer.

Results showed that the soil materials were aggregated irrespective of sampling depth and soil water was retained in both inter-aggregate and intra-aggregate pores. The degree of water repellency varied greatly with both organic matter content and initial water content, and all five different WR classes (extremely, severely, strongly, and slightly water repellency, and wettable) proposed by Bisdom et al. (1993) were recognized. Soil water repellency was first apparent (indicated by slight or strong WR)

at the point where water retained in intra-aggregate pores started to drain. Also, the water repellency was typically enhanced (indicated by extreme WR) when the water retained in intra-aggregate pores was drained to a moderate extent.

For soils within the extremely and severely WR classes, sharp increases in water content from initial water content to saturation on the SWC wetting curves were seen, and the corresponding water entry potentials were located around 0 to +2 cm H2O. Based on the SWC scanning curves, only small differences between re-drying and re-wetting processes were observed within the intra-aggregate pore region. Opposite, the differences became large within the inter-aggregate pore region. This suggests that water is first absorbed into intra-aggregate pores and then retained in inter-aggregate pores in water repellent aggregated soils.

References:

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