Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04635, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04635
EGU General Assembly 2008

Physical factors of sub-critical soil water repellency

H. Czachor
Institute of Agrophysics PAS Lublin (Poland)

The Washburn theory is frequently applied to determine the wetting angle in soils. It concerns the porous medium seen as a set of cylindrical, straight capillaries. It is clear that real soil pores posses at least two important features: variable cross-section and tortuosity. Two simple models of a noncylindrical capillary were applied to show the impact of pore shape and of wetting angle on capillarity driven water movement in soils.

The mathematical model of meniscus movement in a tortuous, variable cross section capillary was developed. The obtained analytical expression for the wetting angle was compared with the appropriate formula concerning the Washburn theory. The wetting angle of water in soil measured on the basis of the measured wetting front kinetics and of Washburn equation has to be an overestimated value for the reason of the wavy, tortuous nature of inter-soil grain pores. Moreover, a new concept of critical wetting angle was proposed. In this approach its value is related to a pore shape understood as a maximal pore wall slope in relation to movement direction and cotangent of Young wetting angle θ. In a wavy pore its value is much lower in relation the classical 90^0 value.

The above conclusions were confirmed by horizontal infiltration experiments. Wetting angles of methyl alcohol and of water directly determined from microscope images of meniscus between spherical glass particles were $0$and 30^0, respectively. Apparent wetting angles calculated from experimental data concerning such glass beads and from Washburn equation were near 70 and 80^0, respectively. The experiments carried out with 5 very different cultivated soil samples taken from humus horizons gave comparable results.

One can expect that relatively small changes of Young wetting angles θ can bring about great differences in wettability and capillary driven water fluxes in soil and have an important impact on water regime in soils. In some cases they can provoke soil water repellency and associated effects: soil water erosion and overland flow as well.