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# Stokes Approach to Preferential Flow at the Darcy-Scale

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Preferential Flow in soils is fast, limited to infiltration and occupies but a small portion of porosity. However, how fast is it, how much water is involved, what is its flow rate, and how far is it carried? Supported with numerous measurements a Stokes approach to preferential flow provides the answers at the operational Darcy-scale. The approach to preferential flow in permeable media (pm) stresses momentum dissipation during viscous flow. Thus, a laminar water film percolates through a pm. The dynamic film is initially determined by the thickness F (m) and the specific contact area L (m2 m-3) per unit volume of the medium. Input to the medium's surface is a pulse with volume flux density q (ms-1) that starts and ends at times TB and TE. A specific pulse and the intrinsic properties of a pm determine F and L. A water content wave (WCW) envelops the spatio-temporal evolution of a water film. A WCW is completely described with a set of analytical relationships that are based on F, L, and the water's viscosity. The approach is an extension of Hagen-Poiseuille's law of flow in concentric conduits. It also evolves seamlessly from extending Darcy's law into non-saturated pm. Experimental determination of F and L follows either from drainage flow or from rapid soil moisture recordings during the passing of a WCW, for instance, with TDR-equipment. Parameters from numerous infiltration experiments in the field, in soil columns, in sand boxes, and lysimeters demonstrate the approach's broad applicability, thus framing the spatio-temporal extensions, velocities and volume flux densities of preferential flows. The specific contact area L is considered the locus of water, heat, particle and solute transfer between a WCW and the sessile parts of a pm. A recent analysis of delayed Br-breakthrough with respect to drainage flow supports the feasibility of the Stokes approach to preferential flow at the Darcy-scale. A perspective of modeling sequences of input pulses will conclude the presentation.