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Spatially averaged water content during infiltration in homogeneous and heterogeneous porous media on the larger laboratory scale

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Water infiltration into unsaturated soil is an important process for groundwater recharge and thus for groundwater quantity and quality. Water infiltration flow is forced by gravity and depends on properties of the porous media and initial water content. The infiltration flow into especially dry porous media may lead to unstable flow. In order to model spatially averaged water content, for example for modeling of water fluxes in larger coupled hydrosystems, understanding about the relevant pattern. Unsaturated flow patterns cannot be predicted using standard models for unsaturated flow (the Richards equation). To upscale the averaged water content it is important to understand the behavior of instabilities. Experiments with homogeneous and layered structures have shown the influence of the soil grain size and distribution on the onset of unstable flow (e.g. Glass et al., 1989b; Sililo and Tellam, 2000; Rezanezhad et al., 2006). In this contribution we analyze infiltration in media with different inclusion patterns to test if structure can stabilize the flow pattern or influences the horizontally averaged water content.

Infiltration in different soil structures was analyzed by carrying out experiments on a larger lab scale. The quasi-2d experiments were done using a 550 mm wide and 300 mm high Hele-Shaw cell. The heterogeneous packings consist of coarse quartz sand (0.7-1.2 mm) as background material and in-between fine grain sand inclusions (0.1-0.3 mm). We built structures from loose packings with high distances between the inclusions to dense packings with small distances between the inclusions. The dynamic behavior of the volume percentage in the background material is compared for different scenarios. The unstable infiltration fronts into differently structured packings show similar characteristics for same initial and boundary conditions. The inclusions lead to a slower infiltration as the fingers stop when they hit an inclusion, but do not stabilize the front, even when densely packed. They have only a small influence on the water content in the background material. We compare the experimental results to different modeling predictions.