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# The role of contact angle and water application rate on flow in sub-critical repellent porous media

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The influence of contact angle (CA) on water retention and flow in sub-critically repellent soils has been contentious. In this study we investigated the effect of contact angle between water and quartz particles (0.3-0.5 mm size) treated to provide different static CAs (33, 48, 56, and 75o) on 2D water flow. Water was applied at the surface of a thin, transparent, uniformly packed flow chamber as a point source at different application rates. The monitored spatial and temporal changes in plume size and internal water content distribution during wetting and drainage stages were analyzed by image analysis. Considering the on-surface point water source as a local perturbation, the differences obtained in plume shape, size, and longitudinal and transversal water content distributions were related to the combined effect of contact angle and water application rate. Results indicate that beyond the effect on plume shape and size, contact angle and water application rate control water content distribution within the plumes. In particular, sharp decreases in water content along the peripheral wetting front were observed, as was the non-monotonous water content variation along vertical cross sections typically associated with unstable flow. At low water application rates, thin and long plumes with saturation overshot behind the wetting front were observed in media having higher contact angles, while wide plumes with lower average water content were observed in media having lower contact angles. In contrast, negligible differences in plume shape and water distribution during wetting were observed at high water application rates in all the media. Yet, differences amongst the plumes became apparent during the drainage stage. Plumes in the media having high contact angles barely changed during the 50 min drainage period while the water content gradient along vertical cross sections turned positive at the lower part and negative along the upper part of the plume in the media of lower contact angle. The possibility of explaining these and other observations by theories and paradigms commonly used in soil physics will be discussed.