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Experimental Investigation of 2D thermal signature and 3D X-Ray Computed Tomography in contrasting Wettable and Water-Repellent Beads

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Abstract: This study presents experimental results investigating spatial patterns of infiltration and evaporation in heterogeneous water repellent media. Infrared camera measurements and 3D X-ray computed tomography imaging was performed across wet-dry cycles on glass beads with engineered patches of water repellence. The imaging revealed spatial variability in infiltration and the redistribution of water in the media resulting in differences in relative evaporation rates during drying. It appears that the spatial organization of the heterogeneity play a role in the breakdown of water repellence at the interface of the two media. This suggests a potential mechanism for self-organization of repellency spatial patterns in field soils. At the interface between wettable and water repellent beads a lateral drying front propagates towards the wettable beads from the repellent beads. During this drying the relative surface temperatures change from a relatively cooler repellent media surface to a relatively cooler wettable media surface indicating the changes in evaporative water loss between the beads of varying water repellence. The lateral drying front was confirmed using thermography in a small-scale model of glass beads with chemically induced repellence and then subjected to 3D X-ray imaging. Pore-scale imaging identified the hydrology at the interface of the two media and at the drying front giving insights into the physics of water flow in water repellent soil.