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Effects of wettability on evaporation behavior from porous media

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Evaporation from porous media is a key process in the hydrologic cycle, waste isolation, biological and food processes and other engineering application. Drying rate and patterns in porous media are strongly influenced by transport properties of the medium. During the first stage of drying (constant and high rate period), continuous liquid pathways connect the receding drying front with evaporating surface and sustain high evaporation rates via capillary induced upward liquid flow. At a certain drying front depth, gravity overcomes capillary driving forces and a transition from liquid flow-supported stage-1 to diffusion-supported stage-2 evaporation occurs. The front depth at this transition marks a characteristic length defined by the width of pore size distribution and wettability of a porous medium both defining the capillary driving forces sustaining the first stage of drying. Wettability of the medium plays a dual role in maintaining continuity of liquid pathways, and defining the strength of capillary gradients. This role was tested in a series of lab experiments monitoring evaporation dynamics from sand media with different wettability properties in Hele-Shaw cells. Additionally, neutron radiography has been used to investigate the drying of hydrophilic and hydrophobic sand at high spatial and temporal resolutions to investigate the impact of wettability on evaporation from porous media and to deduce its potential impacts on morphology and dynamics of drying fronts. Results indicate absence of stage-1 evaporation for hydrophobic sand suppressing evaporative losses. We also observed different drying front dynamics and patterns as compared with hy-

drophilic sand cells. Wettability affects the contact line configuration and motion and hence the deposition of solutes and surface coating during evaporation.