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Evaporation rates and drying front morphology in sand-filled Hele-Shaw cells under different boundary conditions observed with neutron transmission technique

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The important process of evaporation from porous media remains a topic of active research reflecting complex behavior even for simple porous media and boundary conditions. For example, evaporation rate may remain constant despite a drying front receding into the porous medium. We applied the neutron transmission technique to observe and quantify the geometry and dynamics of the drying front for slow and fast external evaporative demand. Results indicate that front morphology follows simple percolation displacement process with little influence of the evaporation rate. The neutron radiography observations revealed an interesting roughing-smoothing cycles resulting from drying front pinning. The changes in near-surface water content distribution with time and the corresponding hydraulic conductivity values were compared with the evaporation rate to assess their impact on mass flow towards the evaporating surface. Results indicate that the common notion of hydraulic conductivity controlling evaporation rate is incomplete and other factors may play a role. The study provides new insights on the effects of evaporation rate, drying front dynamics, and residual water content distribution above a drying front in a coarse porous medium.