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Neutron Imaging of Rapid Water Imbibition in Fractured Sedimentary Rock Cores CHU-LIN CHENG, University of Texas-Pan American, EDMUND PERFECT, BRENDAN DONNELLY, University of Tennessee-Knoxville, HASSINA BILHEUX, Oak Ridge National Laboratory, ANTON TREMSIN, University of California-Berkeley, LARRY MCKAY, VICTORIA DISTEFANO, University of Tennessee-Knoxville, JIANCHAO CAI, China University of Geosciences, LOU SANTODONATO, Oak Ridge National Laboratory — Advances in nondestructive testing methods, such as neutron, nuclear magnetic resonance, and x-ray imaging, have significantly improved experimental capabilities to visualize fracture flow in various important fossil energy contexts, e.g. enhanced oil recovery and shale gas. We present a theoretical framework for predicting the rapid movement of water into air-filled fractures within a porous medium based on early-time capillary dynamics and spreading over rough fracture surfaces. The theory permits estimation of sorptivity values for the matrix and fracture zone, as well as a dispersion parameter which quantifies the extent of spreading of the wetting front. Dynamic neutron imaging of water imbibition in unsaturated fractured Berea sandstone cores was employed to evaluate the proposed model. The experiments were conducted at the Neutron Imaging Prototype Facility at Oak Ridge National Laboratory. Water uptake into both the matrix and fracture zone exhibited square-root-of-time behavior. Both theory and neutron imaging data indicated that fractures significantly increase imbibition in unsaturated sedimentary rock by capillary action and surface spreading on rough fracture faces. Fractures also increased the dispersion of the wetting front.

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