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A Solutal Fingering Instability during Capillary Imbibition in Porous Media CHRISTOPHER GUIDO, NICHOLAS YOUNG, WILLIAM RISTENPART, Dept. Chemical Engineering & Materials Science, University of California, Davis — We report the existence of a solute-driven fingering instability that occurs during capillary imbibition into cellulosic porous media. Contacting a piece of paper with an aqueous solution containing hydrophobic solutes causes the liquid to move forward into the paper. For sufficiently low solute concentrations and sufficiently high ambient humidities, the imbibition front moves forward smoothly as expected. For higher concentrations and lower humidities, however, the imbibition front develops spatially periodic oscillations that grow with time, i.e., a fingering instability occurs. Surprisingly, under these conditions the solute concentration becomes larger at the imbibition front compared to the bulk, contrary to the behaviour expected based on chromatographic separation. We present a stability analysis predicated on solutal changes in the interfacial tension driven by water imbibition into a precursor film ahead of the macroscopically observable air/water interface, and we derive a critical Péclet number above which the interface is unstable.

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