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Preferential paths in yield stress fluid flow through a porous medium[1] JEFFREY GUASTO, NICOLAS WAISBORD, Tufts University, NORBERT STOOP, JÖRN DUNKEL, MIT — A broad range of biological, geological, and industrial materials with complex rheological properties are subjected to flow through porous media in applications ranging from oil recovery to food manufacturing. In this experimental study, we examine the flow of a model yield stress fluid (Carbopol micro-gel) through a quasi-2D porous medium, fabricated in a microfluidic channel. The flow is driven by applying a precisely-controlled pressure gradient and measured by particle tracking velocimetry, and our observations are complemented by a pore-network model of the yield stress fluid flow. While remaining unyielded at small applied pressure, the micro-gel begins to yield at a critical pressure gradient, exhibiting a single preferential flow path that percolates through the porous medium. As the applied pressure gradient increases, we observe a subsequent coarsening and invasion of the yielded, fluidized network. An examination of both the yielded network topology and pore-scale flow reveal that two cooperative phenomena are involved in sculpting the preferential flow paths: (1) the geometry of the porous microstructure, and (2) the adhesive surface interactions between the micro-gel and substrate.

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