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Turbulent flow through channels in a viscously deforming matrix[1]

COLIN MEYER, University of Oregon, IAN HEWITT, Mathematical Institute, University of Oxford, JEROME NEUFELD, BP Institute, Department of Earth Sciences, Department of Applied Mathematics and Theoretical Physics, University of Cambridge — Channels of liquid melt form within a surrounding solid matrix in a variety of natural settings, for example, lava tubes and water flow through glaciers. Channels of water on the underside of glaciers, known as Rothlisberger (R-) channels, are essential components of subglacial hydrologic systems and can control the rate of glacier sliding. Water flow through these channels is turbulent, and dissipation melts open the channel while viscous creep of the surrounding closes the channel leading to the possibility of a steady state. Here we present an analogous laboratory experiment for R-channels. We pump warm water from the bottom into a tank of corn syrup and a channel forms. The pressure is lower in the water than in the corn syrup, therefore the syrup creeps inward. At the same time, the water ablates the corn syrup through dissolution and shear erosion, which we measure by determining the change in height of the syrup column over the course of the experiment. We find that the creep closure is much stronger than turbulent ablation which leads to traveling solitary waves along the water-syrup interface. These waves or 'magmons' have been previously observed in experiments and theory for laminar magma melt conduits. We compliment our experiments with numerical simulations.

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