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Melt Conduit Instability JOHN WHITEHEAD, Woods Hole Oceanographic Institution, MIRANDA HOLMES-CERFON, Courant Institute, New York University — Very long conduits of melt, (lava tubes, magma conduits, glacial drainage tubes) exist in many locations. An idealized model and its stability is analyzed to answer "how far can the fluid flow and remain liquid"? Laboratory experiments show that when a liquid flows in a pipe with the boundary temperature below freezing, a tubular drainage conduit is surrounded by solidified material. When the flow rate into the pipe is set below a fixed value, the tube freezes shut. As flow rate is gradually changed downward toward the freezing value, pressure change across the pipe rises to a maximum, a result that is not in accord with previous theory. A theoretical model allows for a change in radius in the flow direction (similar to some previous injection molding studies), with a mixed pressure-flux upstream boundary condition. Linear stability analyses of this and a simplified model indicate that: (i) for fixed flux, the tube can be infinitely long with minimum pressure as flux is varied; (ii) for fixed pressure drop across the tube, this minimum determines a maximum length; (iii) for the mixed pressure-flux condition, a stable tube exceeds this length. This is a possible explanation for the previously unexplained experimental pressure maximum near freezing. Therefore, distance traveled by melt within the earth might be very sensitive to the conditions that govern upstream pressure and flow rate.

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