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Dear Editor,

We are excited to submit our work “Temporal Evolution of flow in Pore-Networks: From Homogenization to Instability" for consideration as an article in Physical Review Letters. In this manuscript, we study the temporal evolution of flow in networks under dynamic changes in the pore structure, using a combination of analytical and numerical approaches.

Fluid flow through porous materials undergoing a dynamical change in its network of microstructure due to erosion or material deposition is ubiquitous in nature and has numerous environmental and industrial applications. Understanding the dynamical change is essential to improve any of the applications. In light of the plethora of applications, it is surprising that the evolution of porous structures exposed to erosion and deposition has only been partially understood both theoretically and experimentally.

In our work, we study a generic model of network evolution, that includes previously studied models as particular cases. We show that depending on the erosion dynamics, the network statistics may homogenize or become unstable and develop channels. We quantify the phase transition and using a simple model we identify quantitative criteria to distinguish between these regimes and correctly predict the fate of the network, which we corroborate numerically.

Our results highlight the importance of local dynamics and the nature of the feedback mechanism on the long-time global behavior of pore-networks and provide a route to connect local erosion dynamics to global bulk behaviors of the pore-network relevant for many environmental, biological, and industrial applications. We therefore trust that the results will be of interest to the broad readership of PRL. We thank you for your consideration and look forward to hearing from you.

Sincerely,

Ariel Amir