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Is mixing chaotic in laminar flows through rocks?

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Recent studies have shown that chaotic advection is spontaneously produced by laminar flows through granular media such as bead packs, strongly impacting solute mixing rates. This has strong implications for many reactive and biological processes in the subsurface. Chaotic dynamics could also be key in a wide range of environmental and industrial applications driven by mixing. Beside granular media, there is still no evidence that chaos broadly arises in the large variety of porous architectures that exist. In particular, it is unknown how the pore structure and topology can control chaotic dynamics.
In this study, we numerically investigate the mixing behavior of solute for a wide range of natural and engineered porous material that goes from carbonates and sandstones to beadpacks. We quantify chaotic advection by measuring Lagrangian stretching statistics (Lyapunov exponent) and its impact on mixing by estimating the decay of solute concentration variance. We find that stretching and mixing rates vary significantly between the different classes of porous architectures. We also observe that the flow resolution can dramatically impact the statistics and give guidelines for an accurate computation of the Lyapunov exponent.

Participation

In-Person

References

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