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Initial conditions or emergence; what determines dissolution patterns in heterogeneous porous rocks?

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Dissolution of fractured or porous rocks is often accompanied by the formation of highly localized flow paths. Dissolution, in general, does not proceed uniformly, as it is influenced both by the heterogeneities in the rock matrix and by the instabilities associated with the positive feedback loops between the flow, dispersion, and chemical reactions. As a result, distinct channels or "wormholes" develop within the rocks in which both the flow and dissolution focus. In this communication, we aim to investigate how these emerging flow paths are influenced by the initial local inhomogeneities of the porosity field. Our results indicate a surprising insensitivity of the evolving dissolution patterns and flow rates to the amplitude and correlation length characterizing the inhomogeneities. At long times wormhole competition overwhelms the initial variations in aperture distribution, resulting in a universal relation between the separation of the wormholes and their length. This hierarchy of scales even persists in the presence of relatively large inhomogeneities (vugs), which focus the flow at the beginning of the dissolution process, but - if the sample is large enough - with time tend to be overwhelmed by the spontaneous growth of instabilities. A natural consequence of wormhole competition is that the separation between growing wormholes corresponds roughly to their length, something that is borne out by field observations.