Geophysical Research Abstracts
Vol. 19, EGU2017-2284, 2017
EGU General Assembly 2017

Path Selection in the Growth of Wormholes

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Spontaneous growth of wormholes in natural porous media often leads to generation of highly complex flow systems with fractal morphologies. Despite extensive investigations, the underpinning mechanism for path selection during wormholing remains elusive. Here we introduce the concept of cumulative surface (CS) and show that the trajectory of a growing wormhole is one with minimum CS. Theoretical analysis shows that the CS determines the position of the dissolution front. We then show, using numerical simulation based on greyscale data of the fine grained carbonate rock chalk, that the tip of an advancing pore always follows the migration of the most far reaching dissolution front determined from the CS. The predicted dissolution behavior was verified by experimental observation of wormhole growth in chalk using *in situ* microtomography. The results suggest that wormholing is deterministic in nature rather than stochastic. This insight sheds light on engineering of artificial flow systems in geologic formations by exploiting self-organization in natural porous materials.