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Hydrodynamic coupling in microbially mediated fracture mineralisation: formation of self-organised flow channels

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Evidence of fossilised microorganisms embedded within mineral veins and mineral-filled fractures has been observed in a wide range of geological environments. Microorganisms can act as sites for mineral nucleation and can also contribute to mineral precipitation by inducing local geochemical changes. In this study, we explore fundamental controls on microbially induced mineralisation in rock fractures. Specifically, we systematically investigate the influence of hydraulics (velocity, flow rate, aperture) on microbially mediated calcite precipitation. Our experimental results demonstrate that a feedback mechanism exists between the gradual reduction in fracture aperture due to precipitation, and its effect on the local fluid velocity. This feedback results in mineral fill distributions that focus flow into a small number of self-organising channels that remain stable, ultimately controlling the final aperture profile that governs flow within the fracture. This hydrodynamic coupling can explain field observations of discrete flow channelling within fracture-fill mineral geometries where strong evidence of microbial activity is reported.