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How do stylolite networks and stylolite-fracture networks form: insights from modeling

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Stylolites and solution seams are surfaces of localized dissolution, commonly observed in many sedimentary rocks, especially in carbonates. Many stylolites, from diverse origins, locations, and tectonic settings, share a common morphological feature: the amount of dissolved rock in the center of the seam is proportional to the stylolite length. However, kilometer-long stylolites with uniform dissolution along the seam are also observed. In addition we observe anastomosing networks of stylolites, and systems of fractures and veins interconnected with the stylolites. The question addressed here is how to explain these different morphologies and the conditions for their formation. The mechanism of stylolite formation has long been under intensive discussion, and it is currently thought to consist of two coupled processes: pressure solution and clay-enhanced dissolution. Our numerical elasto-plastic spring-network model, that couples these two processes, indeed reproduces growth of all the types of stylolites observed in the field: single self-similar stylolites, infinitely long parallel stylolites, anastomosing network of stylolites, and systems of fractures and veins interconnected with the stylolites. Our results suggest that the initial distribution of clay (bedding planes or dispersed defects) dictates which of the network geometries will form. To further understand how the interconnected systems of stylolites and fractures form, we apply the Eshelby Transformation method and obtain an analytical solution revealing the tensile/shear stress concentrations and predicting the angles of brittle fracturing in the vicinity of stylolites.