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Geometry of and fluid flow in bedding parallel crack-seal veins

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Bedding parallel veins are a common phenomena in many crustal fold and thrust belts. Internally these veins show a complex geometry with different inclusion bands and trails. They are often thought to be indicators of fluid flow along bedding planes and may develop during crack-seal processes. However, it is not clear how the fluid actually migrates along the veins or fractures. We sampled different sets of bedding parallel veins from the Orobic Alps and the Cinque Terre area in Italy and from the Oman mountains in Oman and studied the different internal patterns in thin-sections. In addition we employed X-ray computer tomography to visualize the three-dimensional geometry of the veins. We use inclusion patterns to reconstruct the original fracture surfaces that might have been present during vein opening. The three dimensional fracture surfaces are subsequently used as input parameters for fluid-flow simulations solving the Navier Stokes equations employing Lattice-Boltzmann methods. Fluid flow is simulated with variable fracture apertures reflecting different opening scenarios in order to study the developing flow fields. Depending on the internal geometry of the vein and the associated fracture as well as the opening direction the veins have stable apertures where fluid can flow along the vein or they are subject to fluid pulses where the fracture is only open for a short time.