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Fast sealing of thin cracks

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Many veins are crack-seal veins, formed by repeated cycles of cracking and mineral precipitation (Ramsay, 1980). Actual open crack space is therefore much less than the volume of the final vein. As width and length of veins are usually correlated, open cracks can also be expected to be shorter than the final vein. This raises the question whether such open cracks formed a connected network for fluid flow or that individual cracks remained isolated. In the latter case, vein precipitate must be derived locally. An analytical and numerical model shows that it takes only months to fill a ca. 10 micron crack with calcite by diffusional transport. With tectonic events that cause vein formation lasting thousands to millions of years, crack-seal veins can probably be regarded as closed most of the time. This puts caution to the common notion that vein networks are the product of fracture networks through which fluids once flowed.

Crack-sealing is a deformation mechanism, accommodating extension perpendicular to a vein. The maximum strain rate a vein can accommodate is related to the crack width and sealing time. If the strain rate is too highs, cracks wider than a certain width do not have sufficient time to seal before stress build-up would induce renewed fracturing. Such wide fractures would remain open. As fractures are typically widest in their centre, veins with a transition from crack-seal to syntaxial textures (Bons et al., 2012) may be used to constrain stress and/or strain rate.

Bons, P.D., Elburg, M.A., Gomez-Rivas, E. 2012. A review of the formation of tectonic veins and their microstructures. Journal of Structural Geology 43, 33-62.

Ramsay, J.G., 1980. The crack-seal mechanism of rock deformation. Nature 284, 135-139.