Fluid flow in fractures and vein growth: insights from in-situ experiments

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In high pressure cells in deep parts of sedimentary basins, vein formation by crystallization from a supersaturated fluid flowing along fractures is an important process affecting the evolution of fluid pathways. Supersaturation can arise from gradients in temperature, fluid pressure or chemical potential. We performed flow experiments where crystals were grown in a fracture, with real-time observation in transmitted light microscopy, and compared our results with microsstructures of natural veins in sedimentary rocks.

Natural vein samples consist of faceted, blocky crystals which grew by growth competition, by non-dendritic growth at low supersaturations. Although the vein might be only a few millimetres wide, it can have a length of more than ten metres without any open voids between the vein crystals. Under the experimental conditions (low supersaturation, no spontaneous nucleation taking place but only growth on seed crystals), the crystals fill the fracture near the inflow region, but areas between different crystals and the fracture in the far field remain open. The crystals near the inflow-region grow against the flow direction towards the reservoir. Channelized flow of slightly supersaturated fluid along a fracture cannot explain the formation of completely sealed, zero porosity veins, which are commonly observed in sedimentary rocks. Similar problems arise for advective flow with the fluid entering the void from the matrix. In either case the remaining voids must have been filled by diffusion along the vein grain boundaries.