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Interaction Between Quartz Cementation and Fracturing in Sandstones

Quartz cementation and fractures are complexly interrelated. Quartz cementation influences fracture systems by affecting the rock mechanical properties at the time of fracture formation, which, in turn, influences fracture aperture distributions and clustering. Additionally, cementation affects flow properties of fracture networks by partially or completely occluding fracture pores.

Modeling quartz cementation provides a means to understand the evolution of fracture characteristics when used in concert with basin and geomechanical models. Previous diagenetic models, however, do not consider the impact that fracturing has on quartz cementation. We have developed a 2D quartz cementation model that explicitly considers the influence of fractures on geometry of nucleation surface area in intergranular and fracture pores. The modeled surface area evolves in response to both the cementation process (which tends to reduce the surface area) and the fracture process (which tends to increase the surface area). The model also accounts for the anisotropy in precipitation rate with crystallographic orientation. For quartz cementation in trans-granular fractures this anisotropy significantly affects the extent to which overgrowths can bridge fracture apertures.

In this study, we evaluate the ability of the model to reconstruct the interaction between quartz cementation and fracture development in the Travis Peak Formation. Importantly, the model reproduces (1) the amount of quartz cement in the unfractured portions of the sandstones, (2) the textures of residual pores within quartz occluded fractures, and (3) ‘crack seal’ structures associated with ‘quartz bridges’ that span fracture apertures and tend to be much longer than adjacent quartz overgrowths.