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Dissolution and precipitation of fractures in soluble rock

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Soluble rocks such as limestone, anhydrite, and gypsum are characterised by their large secondary permeability, which results from the interaction of water circulating through the rock and dissolving the soluble fracture walls. This highly selective dissolution process enlarges the fractures to voids and eventually cavities, which then carry the majority of flow through an aquifer along preferential flow pathes.

We employ a numerical model describing the evolution of secondary porosity in a soluble rock to discuss the evolution of single fractures in different rock types. Our main focus is three-fold: The distinction of shallow versus deep flow pathes and their evolution on the one hand; the effect of precipitation of the dissolved material in the fracture, and finally the complication of fracture enlargement in fractures composed of several different soluble materials.

We observe a similar evolution of void space for fractures composed of limestone and gypsum, but on different time scales. For anhydrite, owing to its difference in the kinetical rate law describing the removal of soluble rock, when compared to limestone and anhydrite, the evolution is even faster.

Precipitation of the dissolved rock due to changes in the hydrochemical conditions can clog fractures fairly fast, thus changing the pattern of preferential pathways in the soluble aquifer, especially with depth.

Finally, limestone fractures coated with gypsum, as frequently observed in caves, will result in a substantial acceleration of fracture enlargement with time, thus giving these fractures a hydraulical advantage over pure limestone fractures in their competition for capturing flow.