A MULTILAYER MODEL FOR REACTIVE FLOW IN FRACTURED POROUS MEDIA

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The presence of fractures has an impact on subsurface flows at all scales: flow tends to focus along highly permeable fractures, which can create "shortcuts" in the domain, or, in the case of cemented fractures, we have low permeability barriers in the domain. In the context of reactive transport fractures can be responsible for fast transport of fluid with different chemical composition with respect to the surrounding matrix: this occurs for instance in geothermal reservoirs where water with different salinity, solutes and temperature is injected in the subsurface. This differences in composition and temperature can trigger transformations such as mineral precipitation, dissolution or replacement, with an impact on porosity and fracture aperture. We propose a model to account explicitly for the presence of fractures and their impact on the flow, transport and reactions. We rely on a geometrically reduced model where fractures can be represented by surfaces or lines coupled with the surrounding porous medium. Moreover, we want to account for the fact that, depending on the speed of the reactions relative to the flow velocity, we can observe a thin layer around fractures where most of the geochemical phenomena are concentrated. This layer is in turn represented as a surface with variable-in-time thickness coupled on one side with the fracture "core", on the other with the bulk porous medium. The equations describing flow and transport are thus a coupled of mixed-dimensional PDEs approximated by means of lowest order mixed finite elements, [1]. We will consider a simple model for mineral precipitation dissolution following [2]. To avoid the occurrence of negative concentrations and oscillations when the amount of precipitate approaches zero we adopt an event location strategy to detect the discontinuity in the ODE describing the reaction part, which is, for this reason, split from advection and diffusion by means of a first-order operator splitting.

References

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