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APPROXIMATION OF FLOWS IN FRACTURED POROUS MEDIA BY ENRICHED MIXED FINITE ELEMENTS

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The simulation of flows in fractured porous media is of fundamental importance in several applications, ranging from oil exploitation, soil remediation, $C0_2$ sequestration, etc. In the geological applications above, a suitable modeling of very heterogeneous porous media is needed, to represent layers characterized by different physical properties, fractures or fault zones. Due to this geometric complexity, the construction of a computational grid is usually a challenging task. When the thickness of fractures/faults is very small with respect to the dimension of the domain, (for instance some meters against dozens of kilometers), we can model them as lower dimensional interfaces crossing the domain. The modeling requires to couple the flow in the porous matrix (3D or 2D) with that in the fractures (2D or 1D interfaces, respectively).

In this work, a Darcy's problem on the bulk domain is coupled with a Darcy's problem on the interface to approximate a flow in fractured porous media. The fracture can behave as a barrier or preferential path for the flow, depending of the permeability values.

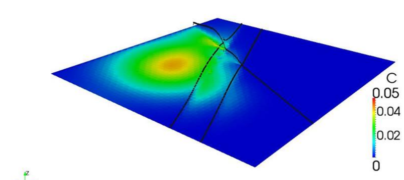

Figure 1: Flow and trasport in a network of fractures

From the numerical point of view, a background mesh is cut by a level set function, representing the fracture, and a problem, in the form of a surface PDE, is posed and solved on the interface [2].

The eXtended Finite Element and CutFEM methods [3, 1] allow for the approximation of these kind of problems with non-matching interfaces thanks to a suitable enrichment of the standard finite element space. For our applications, we chose to approximate the Darcy's problem by mixed finite elements.

A very convenient aspect of these methods is the possibility of having the fracture geometry independent from the underlying grid. As a consequence, this technique to model the fractures can be very general and useful to simplify the geometry of the problem because we avoid the high computational cost of the generation of meshes conformal to the fractures and to the boundaries of the different layers. The definition of suitable enrichments allows to handle a large spectrum of geological configuration, such as the intersection between two fractures.

In this talk, the aforementioned techniques are discussed, focusing on geological applications.

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