# The Coupled Problem of Porous Media Fracture: Numerical Simulation using Phase-Field Modeling


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## ABSTRACT

Numerical modeling of fracture in saturated heterogeneous materials, such as saturated rocks, soils, metal foam or biological tissues, can be carried out using extended continuum porous media theories, which account for the crack nucleation and propagation, deformation of the solid matrix and change in the flow of the interstitial fluids.

Starting with the mathematical modeling and material description, fluid-saturated porous materials with materially incompressible constituents basically represent a volumetrically interacting solid-fluid medium, which can be modeled using the continuum theory of porous media (TPM). Specifically, the proposed treatment assumes steady-state behavior (quasi-static) and neglects all thermal and chemical effects as well as any mass exchange between the constituents. This leads to a strongly coupled system of differential algebraic balance equations (DAE), which demands special numerical schemes for a stable solution, refer to [1] for an overview of the modeling, schemes and references.

Phase-field modeling (PFM) is an important technique for simulation of microstructural evolution such as crack propagation on a macroscopic scale. In the present work, the hydraulic- or tension-derived fracture occurs in the solid matrix and is modeled using a diffusive interface approach, which allows for a robust implementation of the PFM, see, e.g. [2, 3] for detailed discussions. This way of fracture modeling results in an additional partial differential equation to the coupled solid-fluid problem (phase-field evolution relation), which increases the challenges related to stable numerical calculations.

To reveal the ability of the proposed modeling strategy in capturing the basic features of hydraulic fracture, numerical examples using the finite element method, as in the benchmark two-dimensional problem in Fig. 1, are presented.


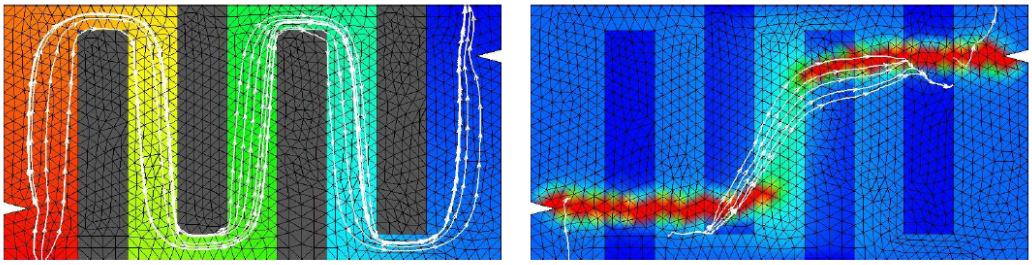

Fig. 1: Fracture-induced changes of the flow path in a perfused, heterogeneous porous medium

## REFERENCES


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