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FRACTURE IN POROUS MEDIA UNDER MULTIPHYSICAL COUPLING

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ABSTRACT

The burgeoning field of underground engineering, including enhanced geothermal system (EGS), carbon sequestration, waste geological disposal and underground energy storage, requires a profound understanding of fracture mechanics in porous media under complex multiphysical conditions. These systems involve the interplay of thermal, hydraulic, mechanical, and chemical (THMC) processes, which significantly influence fracture initiation and propagation. Recent years have seen significant progress in the development of sophisticated constitutive models, numerical algorithms, and computational frameworks that capture the complex interactions between fracturing, fluid flow, heat transfer, and chemical reactions, such as the phase-field method, peridynamics and hybrid approaches. Additionally, machine learning and data-driven approaches are increasingly being integrated with traditional numerical methods to enhance predictive capabilities, reduce computational costs and address uncertainties in fracture modeling. However, challenges remain, including the accurate prediction of fracture nucleation under multi-axial stresses, the development of robust numerical solutions for highly heterogeneous models, the scalability of computational methods for large-scale simulations, and the validation of models against experimental and field data.

This Mini-Symposium aims to explore and showcase recent advancements in the theoretical frameworks and numerical modeling techniques for understanding fracture processes driven or influenced by coupled physical phenomena. Topics of interest include, but are not limited to: (1) Theoretical Advances: Variational fracture theory, multiscale constitutive model for fracture, analytical and semi-analytical solutions for fracture propagation, and impact of material heterogeneity and anisotropy on fracture behavior. (2) Numerical Methods: Multiphysical coupling techniques, algorithms for accelerating computations, cutting-edge computational techniques such as phase-field method, peridynamics, hybrid model and

machine learning integrations. (3) Experimental and Field Validation: Laboratory experiments and field studies that provide critical insights into fracture processes and validate numerical models.

We invite contributions that advance the theoretical understanding, computational tools, and experimental validation of fracture mechanics in porous media under complex physical conditions.