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PhD in experimental geo-mechanics - laboratory investigation of fluid-driven fracture propagation

The propagation of fluid driven fractures in the Earth crust can be engineered by designed fluid injection for a number of applications ranging from soils remediation, pre-conditionning of ore bodies to the stimulation of producing wells in geothermal and gas reservoirs. Such fluid driven fractures also occur naturally at kilometers scale bringing magma from deep underground pressurized chambers to the Earth's surface [1].

Within the context of the development of deep geothermal resources, we aim at better understanding via scaled down laboratory experiments the different hydraulic fracture propagation regimes and more specifically the importance of mixed mode fracture conditions (shear and opening modes) often encountered in naturally fractured rock [2].

This thesis will be strongly experimentally based with an emphasis on geophysical methods. At EPFL, we have recently developed an unique experimental set-up in order to perform fluid induced fracture propagation experiments on cubic sample of 25cm scale under a true tri-axial compressive stress state allowing to properly reproduce deep in-situ conditions. The fracture propagation is monitored via an array of active acoustic sensors (sources and receivers) allowing 4D acoustic imaging. Within this thesis, an array of passive sensors (Acoustic Emission) will be added to reinforce and complement the active acoustic imaging. The student will be involved in the improvement of the data acquisition system, processing of the data and development of new interpretation techniques. Experimental results will be compared in details with theoretical predictions (numerical simulations developed in our lab as well as other teams) during the course of this work (see e.g. [3] for examples). This PhD falls within a larger research project on the modeling of fluid driven fractures propagation at EPFL combining theoretical, experimental and field investigations.

This thesis requires strong interests in i) experimental techniques in mechanics and acoustic / geophysics imaging in particular, and in ii) the mechanics of fracture propagation and the coupled processes at play during fldui-driven fracture propagation in geomaterials.

Interested students should contact Prof. Brice Lecampion (including resume and transcripts), prior to submiting an application to EPFL doctoral school in mechanics (see `https://phd.epfl.ch/edme` for more details about the mechanics doctoral program at EPFL and the application process). This thesis can start anytime. PhD students at EPFL are fully funded (see `https://phd.epfl.ch` for details).

References

[1] E. Detournay. Mechanics of hydraulic fractures. *Annual Review of Fluid Mechanics*, 48:311–339, 2016.

[2] R. Jung. EGS - Goodbye or Back to the Future. In *ISRM International Conference for Effective and Sustainable Hydraulic Fracturing*. International Society for Rock Mechanics, 2013.

[3] B. Lecampion, J. Desroches, R. G. Jeffrey, and A. P. Bunger. Experiments versus theory for the initiation and propagation of radial hydraulic fractures in low permeability materials. *Journal of Geophysical Research: Solid Earth*, 122, 2017.