

Research Topic for the ParisTech/CSC PhD Program

Field : Environment Science and Technology, Sustainable Development, Geosciences

Subfield: Geomechanics

Title: Numerical modeling of induced seismicity due to fluid-injection in Geo-Energy systems

ParisTech School: Mines ParisTech – PSL University

Advisor(s) Name: Frédéric Pellet

Advisor(s) Email: frederic.pellet@mines-paristech.fr

(Lab, website): Centre de Géosciences

Short description of possible research topics for a PhD:

Geoenergy is one of the most promising techniques to exploit renewable energy resources from the Earth in order to limit emissions of green house gas. It can be considered as a base load energy, nearly CO₂ free. Producing electricity from geoenergy requires producing fluids at temperatures larger than 150 °C and at significant mass rates. Such targets can be found either in deep basins, in faulted basements or in volcanic areas.

The economic factors also involve a long operating duration. Thus deep geothermal exploitations are associated to long term fluid circulation and pressure perturbations at great depth, in fractured and faulted zones with possible connections to the basement and are likely associated to a risk of triggering earthquakes and inducing seismicity.

To reduce induced seismicity occurrences, comprehensive Thermo-Hydro-Mechanical numerical simulations formulated with the dynamics equations (equation of motions) are needed. This approach must be validated with field data using inverse analysis techniques. Moreover, because uncertainties affect many features of geothermal reservoirs (fractures density, fault extension and orientation) a stochastic approach is also required.

Required background of the student: Materials Science, Mechanics or Civil Engineering

A list of 5(max.) representative publications of the group:

Ngo, D.T., Pellet, F.L. (2018) Numerical modeling of thermally-induced fractures in a large rock salt mass, *Journal of Rock Mechanics and Geotechnical Engineering*, vol 10, 5 : 844 - 855 (doi.org/10.1016/j.jrmge.2018.04.008)

Pellet F.L. (2017), Rock mechanics is meeting the challenge of geo-energies, *Procedia Engineering, Symposium of the International Society for Rock mechanics, Eurock 2017*, vol 191: 1104 – 1107 (doi.org/10.1016/j.proeng.2017.05.284)

Ngo D.T., Pellet F.L., Bruel D. (2017), Numerical modeling of rock fracturing in geothermal systems, *Proc. 6th International Conference on Coupled THMC Processes in Geosystems, GeoProc 2017, Paris, France*.

Pellet, F.L., Selvadurai, A.P.S. (2016), Rock damage mechanics, Chapter 3, In *Rock Mechanics and Engineering: Vol. 1 Principles*, ISRM Book series, CRC Press / Balkema – Taylor & Francis Group, Leiden, pp 65-107.

Pellet, F.L. (2013), Thermal and mechanical damage to rocks under different loading conditions and consequences for behavior of underground openings *Scandinavian Rock mechanics meeting, Bergmekanikdagen 2013*, Ed. BeFo, Stockholm, pp 1-13.