Internship at the University of Nice Sophia Antipolis
Discretization of geothermal systems in fractured porous media

Roland Masson[1], Simon Lopez[2]
[1] J.A. Dieudonné department of Mathematics, University of Nice Sophia Antipolis, and team Coffee, INRIA Sophia Méditérranée
[2] BRGM, Orléans

November 19, 2013

Geothermal energy is a carbon-free steady energy source with low environmental impact. In countries with a favorable geological context, high temperature geothermal energy can make a significant contribution to power production. On the French territory, it is already an attractive option in volcanic islands context compared to importing fossil fuel. Today, about 5 pourcents of yearly electricity consumption of Guadeloupe already comes from geothermal energy and it is essential for achieving energetic and environmental targets, according to which the overseas territories should produce 50 poucents of their electricity consumption from renewable resources by 2020 and achieve their energy autonomy in 2030. As for other parts of the world, the geothermal development potential of the Caribbean islands is high and several industrial projects are in preparation or already underway, in French overseas territories (Guadeloupe, Martinique) as well as in nearby islands (Dominica, Montserrat).

Numerical modeling has become essential in all phases of geothermal operations. It is used in the exploration phases to assess the geothermal potential, validate conceptual hypothesis and help well siting. Field development and resource management need quantitative estimation to prevent resource exhaustion and achieve its sustainable exploitation (production/injection scenarios). Finally numerical modeling is also helpful in studying exploitation related industrial risks such as the interaction with shallow water levels (drinking water resources, hydrothermal vents or eruption).

The objective of the internship is to implement a numerical model to simulate the flow of the water and steam phases coupled with energy conservation and thermal equilibrium in geothermal systems [3]. The model will take into account the flow in the discrete fracture network acting as major heat and mass transfer corridors coupled with the flow in the surrounding three dimensional porous media (the matrix) [1].

The spatial discretization will be based on a recent combination of a finite volume and a finite element method called Vertex Approximate Gradient scheme. This discretization has been recently adapted to deal efficiently with discrete fracture networks represented as interfaces of codimension one and coupled with the surrounding matrix [2] .

During the internship, an in house isothermal immiscible two phase flow model will be extended to account for the energy conservation equation coupled with the two phase Darcy flow and the steam and water phases appearance and disappearance due to thermal equilibrium

arising in geothermal systems. The model will then be assessed in collaboration with the BRGM on a real test case based on the Bouillante geothermal field located in the West Indies in Guadeloupe and operated by BRGM.

- Applicants should come from a Master 2 in applied mathematics, or an engineering degree with a specialization in applied mathematics. They should have a good knowledge of the discretization of partial differential equations and be familiar with a scientific programming language such as Fortran or C or C++.
- The internship will be held in the J.A. Dieudonné department of Mathematics at the University Nice Sophia Antipolis (UNS) in collaboration with Roland Masson from UNS and Simon Lopez from BRGM. It will be part of the INRIA team Coffee (Complex Flows For Environment and Energy) http://www.inria.fr/equipes/coffee.
- The Internship is between march and july 2014 and will be financed by BRGM. It may be followed by a PhD on the discretization of geothermal systems in fractured porous media.
- Send applications with CV, letter of motivation, and references, to roland.masson@unice.fr, s.lopez@brgm.fr
- Key words: geothermy, finite volume schemes, thermal two phase Darcy flows, fractured porous media

References

[1] V. Martin, J. Jaffré, J. E. Roberts, Modeling fractures and barriers as interfaces for flow in porous media, SIAM J. Sci. Comput. 26 (5) (2005) 1667-1691.

[2] K. Brenner, M. Groza, C. Guichard, R. Masson, Vertex Approximate Gradient discretization of hybrid dimensional two phase Darcy flow in fractured porous media, preprint 2013.

[3] Coumou, D. Numerical simulation of fluid flow in mid-ocean ridge hydrothermal systems. (2008). doi:http://dx.doi.org/10.3929/ethz-a-005682173