

# Numerical Simulation of Fluid Flow and Local Thermal Non-Equilibrium Heat Transfer in Fractured Porous Media

Sahar Hamidi<sup>1\*</sup>, B. Galvan<sup>2</sup>, T. Heinze<sup>1</sup>, A. Kemna<sup>1</sup>

<sup>1</sup>Department of Geophysics, Steinmann Institute, University of Bonn

<sup>2</sup>Centre for Hydrogeology and Geothermics, Université de Neuchâtel

\*hamidi@geo.uni-bonn.de

## ABSTRACT

Geothermal power is a potential alternative energy resource for the future, because of its sustainable, effective and environmentally friendly nature. Due to high costs of drilling and deep exploration, it is beneficial to estimate the heat extraction of a geothermal system in advance. Despite numerous studies in this area, heat production estimation of such a system is still a challenge. There are two main models describing heat transfer between a hot rock and a flowing fluid. One is based on an immediate thermal equilibrium between the rock and the circulating fluid. The other one computes the heat flow in fluid and rock separately but coupled with a fluid-rock heat transfer term. The former is known as local thermal equilibrium model (LTE) and the latter as local thermal non-equilibrium (LTNE).

The previous numerical researches are typically using the LTE assumption; however, studies show the validity of this model only under restricted conditions [1][2]. We present a comparison between these two models using a two-dimensional numerical simulation of coupled fluid flow and heat transport in a porous medium. In order to validate the numerical model, the results of Zhao (2014) are used [3].

Different parameter studies are done to investigate the role of permeability, porosity and fluid injection rate. It is assumed that cold water is flowing through a hot porous medium with a single fracture, while the porosity and permeability of rock and fracture zone are constant. Fluid and rock temperatures are computed over time and the differences between LTE and LTNE model predictions are analyzed. The results show that porosity and water injection rate do not have a large impact on the differences between the model approaches; however, the differences rise extremely as fracture permeability increases. Our results show that transient heat transfer between matrix and fluid should be explicitly accounted for in coupled fluid flow and heat transport models since the assumption of local thermal equilibrium can lead to significant overestimation of the heat transport rates in particular along permeable pathways.

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3. Zhihong Zhao, *On the heat transfer coefficient between rock fracture walls and flowing fluid*, Computers and Geotechnics, 59 (2014):105-111.