Cyclic hydraulic stimulation design to develop Enhanced Geothermal Systems

Günter Zimmermann[1] *, Hannes Hofmann[1], Arno Zang[1], Ove Stephansson[1], Marton Farkas[1], Jeoung Seok Yoon[1], Li Zhuang[2], Kwang Yeom Kim[2], Ki-Bok Min[3]

[1]Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Germany
[2]Korea Institute of Civil Engineering and Building Technology, Goyang, Gyeonggi, Republic of Korea
[3]Department of Energy Systems Engineering, Seoul National University, Seoul, Republic of Korea

* Presenting author. [zimm@gfz-potsdam.de]

Abstract

Enhanced Geothermal Systems (EGS) are required to extract economic amounts of heat from low permeable geothermal reservoirs. We present hydraulic stimulation scenarios applying various cyclic stimulation design. The general aim is to reduce the risks of unwanted seismic events beyond a certain threshold depending on the vulnerability and exposure of people, buildings and infrastructure.

The examples include hydraulic stimulation designs from modelling and from different scales of investigation. By discrete element modelling we could simulate the advantage of a cyclic stimulation design with a reduced seismic released energy compared to a conventional treatment. Experiments on the laboratory scale revealed a reduction of formation breakdown pressure for cyclic loading and were visualised by CT scans. A new advanced protocol of progressively increased cyclic injection and a pulsed injection design for hydraulic fracturing experiments were performed in the Hard Rock Laboratory in Äspö in Sweden and were accompanied by monitoring of acoustic emissions. The cyclic stimulation scheme of loading and unloading the fracturing net pressure led to a lower accompanied seismicity but simultaneously increase the permeability of the treated rock intervals.

From all these experiences a specially adjusted protocol for a field experiment to be carried out at the EGS site in Pohang, Republic of Korea, was developed. The general aim is to keep the seismicity below a tolerable magnitude and develop a suitable down hole heat exchanger for an economic electricity provision.