Geophysical Research Abstracts
Vol. 18, EGU2016-13952, 2016
EGU General Assembly 2016

Crosswell electromagnetic imaging for geothermal reservoir characterization - a feasibility study

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Most regions in the world do not have ready access to natural convective hydrothermal resources. To use deep geothermal heat as a viable energy resource in low-permeability formations, permeable fracture networks have to be created artificially to enable deep fluid circulation for advective heat transport to a production well. Such generation of enhanced geothermal systems (EGS) is studied in the "Deep Underground Geothermal (DUG)" laboratory at the Grimsel pass, Switzerland. Here, an underground experiment is conducted by hydraulically stimulating a pre-existing shear zone within crystalline rock. The objectives of this project are to better describe and understand the processes acting during reservoir generation. We perform a feasibility study to evaluate the capability of low-frequency crosswell electromagnetic (EM) tomography for mapping of stimulation-induced changes in electrical conductivity. First numerical results show that crosswell EM data are generally sensitive to the inter-well conductivity distribution, which is affected by properties such as interconnected porosity, permeability and the presence of fluids. It thereby provides important information for characterization of potential EGS reservoirs. We present a 3-D forward modeling and inversion study using synthetic data and under realistic conditions, these include the true borehole spacing and the observed electromagnetic noise level in the DUG laboratory. Based on these results we discuss the system requirements and the capability of crosswell EM to recover the inter-well structure and stimulation-induced changes. Besides the numerical study we report on the current status of instrumentation and realization of crosswell EM measurements at the DUG laboratory.