Use of the induced seismicity and seismic noise tomography for improving exploration and optimization of geothermal fields

Marco Calo'

Berkeley Seismological Laboratory
215 McCONE HALL #4760 Berkeley, California 94720-4760

The basic principle of an Enhanced Geothermal System (EGS) for exploiting heat stored in rocks at depth is to circulate water through the rock in order to extract the heat. Hot fluids are extracted through production wells and once the heat has been used directly or for producing electricity, cooled water is reinjected through injection wells. Typically the rocks that are targeted for geothermal exploitation are not porous and flow paths are located within natural fractures. Since the initial permeability of the rock mass is generally too low for economic heat production, the boreholes have to be stimulated for connecting them to the surrounding environment and for enhancing the water transmissivity of the natural fracture network.

At the EGS geothermal field of Soultz-sous-Forêts three wells (GPK2, GPK3, GPK4) reach a depth of about 5000 m. In order to connect efficiently the boreholes to the fracture network and to improve the global permeability of the reservoir, the three wells have been stimulated at depth ranging from 4400 to 5000 meters. For each injection test, several hundreds of microearthquakes were recorded with down-hole and the surface network.

In this study I present methods and results for obtaining representative pictures of induced seismicity and of the seismic velocity field able to describe the temporal variation of some physical parameters affecting the reservoir during the injection tests.

However all these studies can be carried out only when an intense induced microseismicity is recorded. Furthermore the induced seismicity is time-dependent and can hardly be used for imaging the features of the reservoir during periods of rest or before the stimulations.

In a second part of this presentation I will therefore present some techniques of seismic imagining, as noise-cross correlation tomography and Vertical Seismic Profile Tomography, which resulted able to provide important insights on the description of the structure of the Soultz geothermal reservoir without the use of the induced seismicity.