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Probing a deep geothermal area in the upper rhine graben with ambient seismic noise : some results based on permanent networks and the dense temporary Estof array

Maximilien Lehujeur, Jérôme Vergne, Adrien Le Chenadec, and Jean Schmittbuhl
Institut de Physique du Globe de Strasbourg / EOST, CNRS; 5 Rue René Descartes, F-67084 Strasbourg Cedex, France

Correlation of ambient seismic noise is an emerging technique that allows to probe the subsoil with no natural or induced seismic sources. The method can be used for passive imaging or for monitoring the temporal evolution of the velocity and the diffracting properties of a medium.

Recently, these techniques have been generalized to very dense seismological networks, which emerge as a new tool for the exploration, the characterization and the monitoring of deep geothermal reservoirs at much lower costs than active methods.

The EstOf experiment that occured in september 2014 proposes to assess the potential of these techniques. Il consists in a dense network of 288 Zland ® seismological stations deployed every $\sim$1.5km over a 15km radius disc around the two geothermal sites of Rittershoffen and Soultz-sous-forêts (Alsace, France). This temporary network complements several permanent and semi-permanent networks initially dedicated to the monitoring of the induced seismicity.

The correlation of one month of ambient seismic noise provides thousands of usable correlation functions in the 0.2-5Hz frequency range. We clearly observe body waves as well as the fundamental mode and first overtone of the Rayleigh wave. The latter phases have been used to build a 3D model of shear wave velocities of the region down to 5km depth. This model, having a lateral resolution of about 2km, appears to be in good agreement with our geological knowledge of the region.

Furthermore, the temporal analysis of the noise correlation functions between some permanent stations indicate sudden changes in the diffracting properties of the subsoil, which are probably linked to the stimulation phases of the reservoir conducted at Rittershoffen in 2013. However, interpreting these observations remains difficult. Laboratory experiments could be a useful approach to better understand the link between the changes in the medium parameters and the resulting effects on the noise-correlation functions.