Geophysical Research Abstracts
Vol. 21, EGU2019-16615, 2019
EGU General Assembly 2019

Investigating the deep structures of the Los Humeros geothermal field, Mexico, with three-component beamforming of ambient seismic noise

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The Los Humeros geothermal field in Puebla, Mexico, is a superhot geothermal system equipped with a geothermal power plant operating since 1990. As part of the GeMex project, a European-Mexican collaboration, the deeper structures (> 2000 m) of this field with temperatures > 380°C are being characterized in a multidisciplinary approach. By gaining a better understanding of the structures and processes, exploitation of the field is meant to be developed.

We use three-component (3C) beamforming to study the seismic noise wavefield recorded on a temporary three-component array in Los Humeros over a period of 1.5 years. 3C beamforming is an array technique that provides the frequency-dependent velocity, propagation direction, and polarization of a seismic wave crossing the array in a given time window. From the polarization, different types of waves, such as Rayleigh and Love waves, P and SV waves, can be distinguished and analysed separately. The feasible frequency range, and hence the sampled depth, is constrained by the array aperture as well as the inter-station spacing within the array.

The station geometry in Los Humeros allows us to investigate the structure of the geothermal field below 2000 m, which has not been mapped so far. In this study we present preliminary results from both surface and body wave analyses with 3C beamforming. Surface wave dispersion curves are inverted for vertical velocity profiles ranging down to several kilometers of depth. For frequency bins with a sufficient noise coverage we estimate azimuthal surface wave anisotropy and track its stability over time. Body wave detections allow us to quantify the composition of the seismic noise wavefield and to monitor its temporal variations that might correlate with micro seismicity in the reservoir.