GeoTHERM
expo & congress

Donnerstag, 20. Februar 2025, 16.20 Uhr
Baden Arena Kongress 2
Oberflächennahe Geothermie

Thursday, 20 February 2025, 4.20 pm
Baden Arena Congress 2
Shallow geothermal energy

The potential of Large-N passive seismology to image meter scale reservoir heterogeneity

Das Potenzial der passiven Large-N-Seismologie zur Darstellung der Heterogenität von Lagerstätten im Meterbereich

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Shallow and deep geothermal resources require reliable reservoir characterisation. Given that both P-wave and S-wave velocity can be related to reservoir properties we demonstrate, using a unique survey acquired in the UK using STYRDE nodes, the potential for passive seismic tomography to characterise meter scale reservoir heterogeneity.

In 2022 a high-density nodal survey (referred to as large-N) was acquired over a 6km2 operating RAF base in the UK. The data have been used to demonstrate the use of the continuous records of ambient seismic noise to derive meter scale variations in seismic velocity, and hence geological heterogeneity. We use the Green's function computed from cross correlations between pairs of nodes to determine group velocities that are used for tomographic inversion. We analyse the spatial variability in ambient noise and the frequency spectra from different anthropogenic signals to understand the variability across an urban area. In our survey the dominant seismic waves recovered in the cross correlations are likely Rayleigh surface waves and therefore we exploit their dispersive nature to produce dispersion curves for the subsequent tomography. We demonstrate the reproducibility and reliability at each step of the workflow, using checkerboard testing and through using different random array configurations, where very similar spatial variations in velocity are derived regardless of pairs of nodes included in the processing flow. We compare conventional array processing to results from eikonal tomography and examine the application of eikonal processing for reservoir monitoring.

This first of a kind processing of a large-N passive seismic survey in the UK demonstrates, using the dispersive nature of surface waves, that complex variations in seismic velocity can be resolved at the meter scale without the need for active seismic sources.