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Ambient seismic noise monitoring and imaging at the Theistareykir geothermal field (Iceland)

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The Theistareykir geothermal field is located at the intersection between the active Northern Rift Zone and the active Tjörnes Fracture Zone in NE Iceland, and its study is of vital importance for further development of local and regional geothermal resources. Since autumn 2017, a seismic network consisting of 21 stations was deployed to monitor the high temperature Theistareykir geothermal field (Iceland). This seismic network belongs to a set of multiparameter networks installed to better understand the underlying structure and behavior of the geothermal reservoir under exploitation.

In this framework, we use the continuous ambient noise seismic records between October 2017 and October 2019 to compute a 3D shear wave velocity model of the geothermal field and to detect possible stress changes due to the injection and production activities. We compute the phase auto- and cross-correlations of the vertical component recordings, measure the Rayleigh wave group velocity dispersion curves, and obtain 2D group velocity maps between 1 and 5 s. The 2D group-velocity maps are used to construct regionalized dispersion curves which are then inverted using a Neighborhood Algorithm to retrieve the 3D Vs model of Theistareykir. We observe various underground structures and identify the locations of possible magmatic or hydrothermal bodies in light of available and newly acquired geological and geophysical data. In addition, we analyze the short and long term temporal evolution of the phase auto-correlations using coda wave interferometry and discuss their relationship to the geothermal field operations. We notice a slightly stronger velocity reduction around the production site in comparison to the surrounding regions.