Passive seismic methods for geothermal exploration: A case study from the Jinqu Basin (China)

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Geothermal resources are considered as underutilized contributors to diversification of the growing energy needs worldwide. Like several other nations, China embarked on a program to explore potential geothermal reservoirs. We present a case study from the Jinqu Basin in southeastern China where ambient seismic noise tomography was applied to investigate the geologic structure in regard to its probability for hosting temperate ground water in large depths. The Jinqu Basin is located ca. 300 km southwest of Shanghai and comprises sandstones and conglomerates on top of volcanic units. Heatflow is around 75–80 mW/m², and temperate surface water is characteristic for the region. A passive seismic survey was conducted to identify potential zones with increased fracture density. The passive method allows to cover large areas in short time at minimal costs, while it provides low-resolution velocity models only. Nonetheless, in the initial stage of exploration low-resolution and spatially extended 3D models are required to plan detailed reflection seismic acquisition and drilling locations in later phases. The passive seismic survey comprised 192 recorders, which were deployed for 5 days in a 20 km² wide area. Continuous recording of ambient seismic energy (e.g., traffic noise, cultural noise) allowed for the application of interferometric analysis and tomographic inversion. The main result is a 3D shear-wave velocity model, which extends to a depth of ca. 2 km. The model shows a low-velocity anomaly which correlates with low electrical resistivity from a previous 2D magneto-telluric campaign. This anomaly is interpreted for a zone of increased fracture density and will be considered for future active seismic acquisition. It is concluded that passive seismic methods are useful for large scale geologic exploration in the context of geothermal reservoirs because of their low costs and short acquisition time. The obtained shear-wave velocities are sensitive to fracture density, which is an important property of potential reservoirs. Depending on the type and availability of ambient seismic noise, the method can be scaled from a depth of few tens of meters to several kilometers.