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Wave propagation simulation on a 3D model of the Ruhr district for locations of seismic monitoring.

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The Ruhr district meets the necessary elements to carry out geothermal projects due to its geothermal potential and demand, as it is a densely populated industrial area. Currently, there are projects for direct use, whereas projects for electricity generation are planned. The latter, due to greater depths, reservoir enhancement techniques are required in some cases. This may increase the associated seismic risk which should be elaborated in detail.

With available data, a three-dimensional geological and structural model was created. The shallower parts have been widely studied and documented by mining activity in the Ruhr region during the last century. Below a depth of 1 km, data are scarce, and uncertainties increase. The full elastic wavefield emitted by a realistic seismic source has been simulated using a finite differences scheme and the derived geological model. The elastic properties were estimated with well data. The source has common characteristics of real seismic events in the area.

The wave propagation simulations let us analyze the seismic response with different sources and velocities models. Three cases are considered, two seismic events with distinct depths based on real events. The third case is based on the proposed location of a deep geothermal project.

Especially for the case with the deeper source, the areas with relatively high amplitudes of displacement correlated with structural features of the model. Applying the imaging condition of maximum energy density allows us to define zones with a potentially increased seismic risk that should be monitored more closely.