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Combined analysis of passive and active seismic measurements using additional geologic data for the determination of shallow subsurface structures

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A detailed knowledge of subsurface structure is essential for geotechnical projects and local seismic hazard analyses. Passive seismic methods like microtremor measurements are widely used in geotechnical practice, but limitations and developments are still in focus of scientific discussion. The presentation outlines microtremor measurements in the context of microzonation in the scale of districts or small communities. H/V measurements are used to identify zones with similar underground properties. Subsequently a shear wave velocity (Vs) depth profile for each zone is determined by array measurements at selected sites. To reduce possible uncertainties in dispersion curve analyses of passive array measurements and ambiguities within the inversion process, we conducted an additional active seismic experiment and included available geological information.

The presented work is realized in the framework of the research project MAGS2 (“Microseismic Activity of Geothermal Systems”) and deals with the determination of seismic hazard analysis at sites near deep geothermal power plants in Germany. The measurements were conducted in the Upper Rhine Graben (URG) and the Bavarian molasses, where geothermal power plants are in operation. The results of the H/V- and array-measurements in the region of Landau (URG) are presented and compared to known geological-tectonic structures. The H/V measurements show several zones with similar H/V-curves which indicate homogenous underground properties. Additionally to the passive seismic measurements an active refraction experiment was performed and evaluated using the MASW method („Multichannel Analysis of Surface Waves“) to strengthen the determination of shear-wave-velocity depth profile. The dispersion curves for Rayleigh-waves of the active experiment support the Rayleigh-dispersion curves from passive measurements and therefore provide a valuable supplement. Furthermore, the Rayleigh-wave ellipticity was calculated to reduce ambiguity in the inversion process. The obtained Vs-profiles at the selected site are in good agreement with the results of the refraction seismic experiment.