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Imaging a shallow salt diapir beneath the densely built-up city area of Hamburg, Northern Germany, using ambient noise recordings

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The city area of Hamburg is geologically characterised by poorly consolidated sediments at shallow depths and emplacement of salt diapirs. Subrosion and karst may lead to the formation of sinkholes and the development of solution dolines. During the last century, 20 collapse earthquakes took place and so far, more than 30 sinkholes and dolines are known in the metropolitan region. The project aims to gain information on the most prominent salt diapir (Othmarschen-Langenfelde diapir). We use passive recordings of ambient seismic noise to map the depth of the salt dome interface which represents a strong impedance contrast in shear wave velocity. Single station as well as small aperture array recordings are performed. For the single station measurements, H/V ratios are investigated. A certain peak frequency indicates the existence of a shear wave impedance contrast in the subsurface. A Rayleigh wave dispersion curve determined from array measurements can be inverted for the shear wave velocity profile at the measurement site. To simplify repetitions of station deployments required to capture the broadest possible range of frequencies, we develop a wireless array analysis system (WARAN) to obtain analysis results already during the field measurement. Up to now, a total of 13 array surveys has been conducted with the number of array geometry setups varying from 3 to 8. Approximately 200 single station measurements have been performed additionally. Results show differences in the location of the diapir rim compared to the interpretation of a few existing refraction seismic profiles. Structural details are revealed in regions where the salt dome interface is shallow. The general shape of the salt dome derived from H/V measurements fits with the gravimetric anomaly deduced from a survey including more than 500 landmark points.