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Seismic Exploration and monitoring of geothermal reservoirs using distributed fibre optic Sensing - the joint project SENSE

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For a successful operation of energy or resources use in the subsurface, exploration for potential reservoir or storage horizons, monitoring of structural health and control of induced seismic unrest are essential both from a technical and a socio-economic perspective. Furthermore, large-scale seismic surveys in densely populated areas are difficult to carry out due to the effort required to install sources and receivers and are associated with high financial and logistical costs. Within the joint project SENSE*, a seismic exploration and monitoring approach is tested, which is based on fibre-optic sensing in urban areas.

Besides the further development of sensing devices, the monitoring of borehole operations as well as the development of processing workflows form central parts of the joint activities. In addition, the seismic wave field was recorded and the localisation of the cables was tested along existing telecommunication cables in Berlin. Further testing of measuring conditions in an urban environment was also conducted along an optic fibre separately laid out in an accessible heating tunnel.

We suggest a workflow for virtual shot gather extraction (e.g., band pass filtering, tapering, whitening, removal of poor traces before and after cross-correlation, stacking), that is finally including a coherence-based approach. The picking of dispersion curves in the 1-7 Hz frequency range and inversion yield a shear wave velocity model for the subsurface down to a. 300 m depth. Several velocity interfaces are evident, and a densely staggered zone appears between 220-270 m depth. From lab measurements a distributed backscatter measurement in OTDR mode shows that high reflections and moderate loss at connectors can be achieved in a several hundred m distance. Depending on drilling campaign progress, we will also present first results gained during the borehole experiment running until February 2022.

* *The SENSE Research Group includes in addition to the authors of this abstract Andre Kloth and Sascha Liehr (DiGOS), Katerina Krebber and Masoud Zabihi (BAM), Bernd Weber (gempa), and Thomas Reinsch (IEG).*