EGU22-11311
https://doi.org/10.5194/egusphere-egu22-11311
EGU General Assembly 2022

Overcoming limitations of seismic monitoring using fibre-optic distributed acoustic sensing

Regina Maaß[1], Sven Schippkus[1], Céline Hadziioannou[1], Benjamin Schwarz[2], Charlotte Krawczyk[2,3], and Philippe Jousset[2]
[1]University of Hamburg, Institute for Geophysics, Hamburg, Germany
[2]Helmholtz Centre Potsdam GFZ, German Research Centre for Geosciences, Potsdam, Germany
[3]Technische Universität Berlin, Institute for Applied Geosciences, Berlin, Germany

Seismic monitoring refers to the measurement of time-lapse changes of seismic wave velocities and is a frequently used technique to detect dynamic changes in the Earth's crust. Its applications include a broad range of topics, such as natural hazard assessment and structural health monitoring. To obtain reliable measurements, results are usually stacked over time. Thereby, temporal resolution is lost, which makes the measurement less sensitive to short-term environmental processes. Another problem is that conventional datasets often lack spatial density and velocity changes can only be attributed to large areas. Recently, distributed acoustic sensing (DAS) has gained a lot of attention as a way to achieve high spatial resolution at low cost. DAS is based on Rayleigh-scattering of photons within an optical fibre. Because measurements can be taken every few meters along the cable, the fibre is turned into a large seismic array that provides information about the Earth's crust at unprecedented resolution.

In our study, we explore the potential of DAS for monitoring studies. Specifically, we investigate how spatial stacking of DAS traces affects the measurements of velocity variations. We use data recorded by a 21-km-long dark fibre located on Reykjanes Pensinsula, Iceland. The cable is sampled with a channel spacing of 4 meters. We analyze the energy of the oceans microseism continuously recorded between March and September 2020. At first, we stack adjacent traces on the fibre in space. We then cross correlate the stacks to obtain approximations of the Green's functions between different DAS-channels. By measuring changes in the coda waveform of the extracted seismograms, velocity variations can be inferred. Our analysis shows that spatial stacking improves the reliability of our measurements considerably. Because of that, less temporal stacking is required and the time resolution of our measurements can be increased. In addition, the enhancement of the data quality helps resolve velocity variations in space, allowing us to observe variations propagating along the cable over time. These velocity changes are likely linked to magmatic intrusions associated with a series of repeated uplifts on the Peninsula. Our results highlight the potential of DAS for improving the localization capabilities and accuracy of seismic monitoring studies.