



Strain and ground-motion monitoring at magmatic areas: ultra-long and ultra-dense networks using fibre optic sensing systems

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The fibre optic distributed acoustic sensing technology (DAS) is a “new” sensing system for exploring earth crustal elastic properties and monitoring both strain and seismic waves with unprecedented acquisition characteristics.

The DAS technology principle lies in sending successive and coherent pulses of light in an optical fibre and measuring the back-scattered light issued from elastic scattering at random defaults within the fibre. The read-out unit includes an interferometer, which measures light interference patterns continuously. The changes are related to the distance between such defaults and therefore the strain within the fibre can be detected. Along an optical fibre, DAS can be used to acquire acoustic signals with a high spatial (every meter over kilometres) and high temporal resolution (thousand of Hz).

Fibre optic technologies were, up to now, mainly applied in perimeter surveillance applications and pipeline monitoring and in boreholes. Previous experiments in boreholes have shown that the DAS technology is well suited for probing subsurface elastic properties, showing new ways for cheaper VSP investigations of the Earth crust.

Here, we demonstrate that a cable deployed at ground surface can also help in exploring subsurface properties at crustal scale and monitor earthquake activity in a volcanic environment. Within the framework of the EC funded project IMAGE, we observed a >15 km-long fibre optic cable at the surface connected to a DAS read-out unit. Acoustic data was acquired continuously for 9 days. Hammer shots were performed along the surface cable in order to locate individual acoustic traces and calibrate the spatial distribution of the acoustic information. During the monitoring period both signals from on- and offshore explosive sources and natural seismic events could be recorded. We compare the fibre optic data to conventional seismic records from a dense seismic network deployed on Reykjanes. We show that we can probe and monitor earth crust subsurface with dense acquisition of the ground motion, both in space and in time and over a broad band frequency range.