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Strain accumulation along a 21km long optic fibre during a seismic crisis in Iceland, 2020

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Slow slip plays an important role in accommodating plate motion along plate boundaries throughout the world. Further understanding of the interplay between aseismic and seismic slip has gained particular attention as it is crucial for the assessment of seismic risk. A wide range of instruments and acquisition techniques exist to quantify tectonic deformation which spans multiple orders of magnitude in duration as well as spatial extend. For example, seismometers acquire dense temporal data, however are sparsely deployed, leading to spatial aliasing. As opposite, remote sensing techniques have wide aperture but rather crude temporal resolution and accuracy (mm-range). In selected areas, strain is continuously measured with laser or borehole strainmeters.

In this contribution, we investigate the distribution of permanent strain along a telecommunication optic fibre on the Reykjanes Peninsula, South West Iceland. Continuous strain-rate was recorded via DAS (Distributed Acoustic Sensing) over a period of six months during the recent unrest of the Svartsengi volcano which began in January 2020. The interrogated fibre connects the town of Gridavik with the Svartsengi geothermal power plant and was patched to a second fibre leading to the western most tip of the Reykjanes Peninsula. It is approximately between 10 and 20km west of the active volcanic area which produced abundant local seismicity as well as surface uplift and subsidence in areas crossed with the optical fiber. The fibre was installed in a trench at less than one meter depth and consists of two roughly straight segments of 7 and 14km length. Whereas the longer segment trends WSW parallel to the strike of the Mid-Atlantic Ridge at this geographic height, the shorter segment trends NEN and thus almost coincides with the maximum compressive stress axis of the region.

Inspection of the spatio-temporal strain-rate records after the occurrence of local earthquakes indicates the accumulation of compressive as well as extensive strain in short fibre sections of a few dozen meters which could correlate with local geologic features like faults or dykes. This holds for events of M~2.5 and fibre segments in epicentral distances of more than 20km. Preliminary results regarding the total deformation of the fibre as response to an individual seismic event show a distinct behaviour for differently oriented fibre segments correlating with the overall stress regime, i.e. shortening in the order of some dozen nanometers in the direction of SHmax. Unfortunately, recordings of the two largest intermediate M>=4.8 events indicate saturation of the

recording system or loss of ground coupling thus preventing a meaningful interpretation of their effect on permanent surface motion.
Perspectively, our efforts aim at investigating the feasibility of distributed optical strain-rate measurements along telecommunication infrastructure to track locally accumulated strain.