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## Strombolian seismic activity characterisation using fibre-optic cable and distributed acoustic sensing

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Stromboli is an open-conduit volcano characterized by mild intermittent explosive activity that produces jets of gas and incandescent blocks. Explosions occur at a typical rate of 3-10 events per hour, VLP signals have dominant periods between 2 and 30 seconds. Seismic activity is also characterized by less energy short-period volcanic tremor related to the continuous out-bursting of small gas bubbles in the upper part of the magmatic column. The high rate of activity as well as the broadband frequency contents of emitted signals make Stromboli volcano an ideal site for testing new techniques of fibre-optic sensing.

In September 2020, approximately 1 km of fiber-optic cable was deployed on the Northeast flank of Stromboli volcano, together with several seismometers, to record the seismic signals radiated by the persistent Strombolian activity via both DAS and inertial-seismometers, and to compare their records.

The cable was buried manually about 30 cm deep over a relatively linear path at first and in a triangle-shaped array with 30-meters-long sides in the highest part of the deployment. The strain rate was recorded using a DAS interrogator Febus A1-R with a sampling frequency of 2000 Hz, a spatial interval of 2.4 m and a gauge length of 5m. Data were re-sampled at 200 Hz. A network of 22 nodes SmartSolo IGU-16HR 3C geophones (5 Hz) has been distributed over the fibre path. A Guralp digitizer equipped with a CMG CMG-40T 30 sec seismometer and an infrasound sensor were placed in the upper part of the path. The geolocation of the cable was obtained by performing kinematic GPS measurements with 2 Leica GR25 receivers. All equipment recorded simultaneously several hundreds of explosion quakes between September 20 and 23.

Data analysis provided the following main results:

- DAS interrogator clearly recorded the numerous explosion-quakes which occurred during the experiment, as well as lower amplitude tremor and LP events.
- DAS spectrum exhibits a lower resolution at long periods with a cut-off frequency of approximately 3 Hz.

- VLP seismic events generated by Strombolian activity are identified only at a few DAS channels belonging to a specific portion of the path, which seems affected by local amplification. At these channels, they display waveforms similar to those sensed by the Guðralp CMG-40T.
- Comparison of DAS strain waveform to particle velocity recorded by co-located seismometers shows a perfect match in phase and a good agreement in amplitude.
- Beamforming methods have been applied to nodes data located on the upper triangle and to strain rate data, both in the 3-5 Hz frequency band. Slightly different back-azimuths were obtained, values estimated via DAS point more to the southwest with respect to the crater area. Apparent velocities obtained with DAS recordings have lower values compared to those obtained with nodes.