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Detecting Slow Deformation Signals Preceding Dynamic Failure: A New Strategy For The Mitigation Of Natural Hazards (SAFER)

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1. Introduction and background
Pre-failure monitoring is a major aim in territorial risk assessment and mitigation. Detecting slow deformation signals preceding dynamic failure is a main goal for developing early-warning systems. We deployed a microseismic network for monitoring a rockfall at Madonna del Sasso (VB, Italy) with the aim to identify the characteristic signs of pre-failure processes. The array consists of 4 triaxial geophones (4.5 Hz).

2. The site
Madonna del Sasso site is located in NW Italy (Fig. 1a). It is a granitic cliff (Granito di Alzo), with a height of about 200 m (Fig. 1b).

3. Geophysical characterization
Electrical Resistivity Tomography (ERT)
- 72 electrodes with 1 m spacing
- Wenner-Schlumberger and Dipole-Dipole array
- Data inversion with Res2Dinv software (Fig. 3)

Cross-hole Seismic Tomography
- Borehole impacter source
- Prototype borehole string with 8 three-component geophones (10 Hz)
- Hammer (P and S waves)
- Three-component surface geophones (4.5 Hz)
- Manual picking of the first arrival time for P and S waves
- Data inversion with GeoTomCG software (Fig. 4 and Fig. 5)

4. Microseismic monitoring
- 4 triaxial geophones (4.5 Hz)
- Multichannel acquisition system (Granite – Kinematics, Inc.)
- 4 temperature probes
- STA/LTA detection algorithm
- Different number of trigger votes for each station

First results:
Nearly 1500 recorded events (Fig. 7) with different waveforms, duration and frequency content.

From a preliminary analysis and classification, less than 20 events (1%) seems to have signal properties (Fig. 8) related to micro-fracturing processes inside the rock mass.

5. Conclusions and future work
- Preliminary recorded data indicate the occurrence of microseismic swarms with different spectral contents
- A small but significant percentage can be related to micro-racking processes inside the rock mass.
- A 3D reconstruction of the cliff will be carried out to obtain a seismic velocity model for the localization of microseismic events.
- Additional geophones and accelerometers provided by SEIS-UK will be installed in the next future.
- Rock physical and mechanical characterization along with rock deformation laboratory experiments will be carried out.