The Pollino seismic sequence: Can shear wave anisotropy monitoring help earthquakes forecast?

[Poster]

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The Pollino seismic sequence: Can shear wave anisotropy monitoring help earthquake forecast?

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Abstract

Since the late 19th-early 20th century seismologists developed theories that included variations of the elastic property of the Earth crust and the state of stress and its evolution crust prior to the occurrence of a large earthquake. Among them the others the theory of the dilatancy (Scholtz, 1974) when a rock is subject to stress, the rock grains are deforming gradually micro-cracks, thus the rock itself is weakening in volume. Inside the fractured rock, fluid circulation and pore pressure play an important role in earthquake nucleation, by facilitating the effective stress. Thus measuring the variations of shear wave speed and of anisotropy parameter in time can be highly informative on how the stress leading to a major fault failure build up.

In 1980s and 90s each kind of mechanism of the earthquake process was given to scientific and ground-motion studies, which are important since these are the basic tools for understanding the seismic phenomena and their precursors.

Projects in Carrara and L’Aquila 2009

Two different approaches of the obtained anisotropies parameters in the two areas: 1) Last direct shear diagrams, with petal size proportional to the number of the measurements, along with earthquake epicentres, focal mechanisms and main structural feature (red lineaments): red from INGV Working Group (2010); 2) mean fast directions (thinner lines scaled to the normalized delay time computed at each station from Di Stefano et al., 2012). Exception made for station INGVA, for the sections at the other stations and the total of the measurements. These results are almost perfectly aligned to the stress, which strikes about N50W. Comparison between times of maximum shear wave velocity and anisotropy parameters at INQALP, N45°S shear wave polarizations directions. D. Ambrasey et al. (2010). A total number of 9 stations in INQA, B. Normalized shear wave velocity time series. C. Ambrasey et al. (2008). D. Ambrasey et al. (2008). Note that the seismicity and the anisotropy parameters in the area are not significantly correlated.

To understand how the anisotropic parameters vary quickly after an earthquake-motion recorded at one station. We performed detailed monitoring of the area and of the individual events. We showed that the azimuth of the anisotropy parameters (in the area of the epicentre) is highly variable and that we can infer that these parameters can be used for the detection of the stress state.

L’Aquila 2009

Pollino 2010-2013

The fast wave diagrams in the top corners are frequency plots representing how fast directions tend to vary with time. The diagrams display the azimuth of the anisotropy parameter (in the area of the epicentre) is highly variable and that we can infer that these parameters can be used for the detection of the stress state.

Anisotropica parameters for the Abruzzo (Italy) ejecta at the stations in the area (over the map of the Abruzzo alpine area). Spatially distributed sensor (red line). The rocks are present at all stations at a significant number of measurements. The fast wave diagrams in the top corners represent the azimuth of the anisotropy parameter (in the area of the epicentre) is highly variable and that we can infer that these parameters can be used for the detection of the stress state.

MMN Temporal Variation

Temporal trend of fast directions and time of MMN, averaged over time for the period 2010-2013. The red bar is the average and the color changing assignment to events with magnitude greater than 3.5. (24/1/2011, 20/12/2012 M 3.4, 20/08/2012 M 3.1, 2/7/2013 M 3.0). The grey circles are the individual measurements. The gray line segment assigned values over 10 measurements. We consider all measurements with c greater than 0.7 and delay time greater than 0.3 S. The averaged results are obtained using a sliding time window of 600 seconds and overlap of 100 to 1000 measurements. The fast wave diagrams in the top corners represent the azimuth of the anisotropy parameter (in the area of the epicentre) is highly variable and that we can infer that these parameters can be used for the detection of the stress state.

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References

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Note: The figures in this paper were prepared using the Adobe Illustrator software.