Geophysical Research Abstracts
Vol. 15, EGU2013-10741, 2013
EGU General Assembly 2013

Seismic measurements to reveal short-term variations in the elastic properties of the Earth crust

Davide Piccinini (1), Lucia Zaccarelli (2), Marina Pastori (1), Lucia Margheriti (3), Francesco Pio Lucente (3), Pasquale De Gori (3), Licia Faenza (3), and Gaia Soldati (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Sismologia e Tettonofisica, Italy, (2) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna, Italy , (3) Istituto Nazionale di Geofisica e Vulcanologia, Centro Nazionale Terremoti, Italy

Since the late the late '60s-early '70s era seismologists started 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 the others the theory of the dilatancy (Scholz et al., 1973): when a rock is subject to stress, the rock grains are shifted generating micro-cracks, thus the rock itself increases its volume. Inside the fractured rock, fluid saturation and pore pressure play an important role in earthquake nucleation, by modulating the effective stress. Thus measuring the variations of wave speed and of anisotropic parameter in time can be highly informative on how the stress leading to a major fault failure builds up.

In 80s and 90s such kind of research on earthquake precursor slowed down and the priority was given to seismic hazard and ground motions studies, which are very important since these are the basis for the building codes in many countries. Today we have dense and sophisticated seismic networks to measure wave-fields characteristics: we archive continuous waveform data recorded at three components broad-band seismometers, we almost routinely obtain high resolution earthquake locations. Therefore we are ready to start to systematically look at seismic-wave propagation properties to possibly reveal short-term variations in the elastic properties of the Earth crust.

One seismological quantity which, since the '70s, is recognized to be diagnostic of the level of fracturation and/or of the pore pressure in the rock, hence of its state of stress, is the ratio between the compressional (P-wave) and the shear (S-wave) seismic velocities, the Vp/Vs (Nur, 1972; Kisslinger and Engdahl, 1973). Variations of this ratio have been recently observed and measured during the preparatory phase of a major earthquake (Lucente et al. 2010). In active fault areas and volcanoes, tectonic stress variation influences fracture field orientation and fluid migration processes, whose evolution with time can be monitored through the measurement of the anisotropic parameters (Miller and Savage, 2001; Piccinini et al., 2006). Through the study of S waves anisotropy it is therefore potentially possible to measure the presence, migration and state of the fluid in the rock traveled by seismic waves, thus providing a valuable route to understanding the seismogenic phenomena and their precursors (Crampin & Gao, 2010). In terms of determination of Earth crust elastic properties, recent studies (Brenguier et al., 2008; Chen et al., 2010; Zaccarelli et al., 2011) have shown how it is possible to estimate the relative variations in the wave speed through the analysis of the crosscorrelation of ambient seismic noise.

In this paper we analyze in detail two seismological methods dealing with shear wave splitting and seismic noise cross correlation: a short historical review, their theoretical bases, the problems, learnings, limitations and perspectives.

Moreover we discuss the results of these methods already applied on the data recorded in the L'Aquila region, before and after the destructive earthquake of April 6th 2009, represent their self an interesting case study.