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Earlier appraisal of seismic and volcanic events by means of recurrence quantification analysis of AE time-series: preliminary results

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Earlier appraisal of seismic and volcanic events by means of recurrence quantification analysis of AE time-series: preliminary results

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Abstract
Recurrence Quantification Analysis (RQA) appears one of most promising non linear time series techniques for the analysis of complex systems [1]. Recently, it has been applied to investigate acoustic emissions from both rocky samples [2] and complex seismic processes dynamics [3].
Friction induced vibrations may occur whenever two objects, once put in contact, slide with respect to each other. Typical examples are active faults inside seismogenic zones, train wheels running along tight curves with their narrow-banded noise, friction in bearings, and events at microscopic scale in molecular physics.
Within this context, the application of RQA to Passive Acoustic Emission (AE) signals released, at ultrasonic frequencies, by stressed rocks in the Earth's crust beyond a specific threshold (event) is presented. The data records are constituted by AE time-series collected nearby active tectonic and volcanic sites in Italy, Greece and Argentina. The AE data were gathered, with 30 sec of sampling rate, by piezoelectric transducers, operating at two ultrasonic frequencies (typically 25 and 150 kHz), fixed to a rock [4, 5, 6]. Usually, the data set is very huge and the AE signal amplitude changes with to the acoustic impedance, associated with local rock stress conditions and particularly sensitive to fracture density and water content. The evolution features of the quiescence and activation status of the crustal structure is examined by applying the RQA method to the AE time-series focusing on characteristic recurrence patterns, disregarding the signal amplitude. RQA is a quite simple processing method which considers few parameters describing the whole complexity of a signal. The RQA parameters are simply reckoned from the so-called "Recurrence Plot" [7] and are used to monitor quantitative changes in dynamics of temporal distribution [2], loss of synchronization of dynamic mechanism or spatial irregularities occurring along time [8]. In particular, this work aims at defining few descriptors that are able to explain the main characteristics of the AE signals and identifying anomalies to be related to crustal stress modifications or paroxysmal volcanic activities in the monitored seismic and volcanic areas [4,5].

Keywords
Recurrence Quantification Analysis, Acoustic Emissions, Signal Analysis, Friction Induced Vibrations, volcanoes, earthquakes

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