An algorithm for rockfall events automatic detection and classification in seismic monitoring

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Rockfall is a kind of sudden, difficult to monitor and predict geohazard. The seismic signal emitted by a rockfall carries with its abundant physical and mechanical information. For this reason, it can be meaningful for researchers to back analyse the event location, onset time, volume, trajectory, and so on. However, the automatic detection and classification of rockfall events through seismic monitoring for forecasting purposes are still under developing, especially in seismic station arrays.

A seven months-long seismic monitoring of a former quarry in Central Italy was performed by means of four tri-axial velocimeters that acquired continuously at 200 Hz. During this monitoring period a man-induced rockfall simulation was performed, releasing 90 blocks of different size from the benches of the quarry. During the test, several rockfall signals and a variety of other natural events have been recorded. The transient analysis allowed to calibrate an algorithm for seismic events automatic detection and classification written ad hoc, within the Matlab environment. For the events detection, the STA/LTA method combined with multiple logical determinations was used. Furthermore, nine significant features to classify seismic events in a rockfall environment based on frequency, amplitude, seismic waveform, and duration of the signal have been defined. In particular, a five seismic event-types (rockfall, earthquake, tremor, multi-spike events and subordinate multi-spike events) classification has been proposed. Each component (vertical, East-West and North-South) of each station within the array was analysed, and then a fusion process was performed. The method fuses, at a given time, the events from the three components of one station, and then all data from the station array into a final event-type series. The whole monitoring dataset was analysed, and all the seismic events were detected and classified according to the five event-type classification.