Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08903, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08903
EGU General Assembly 2008

Rock fall induced seismic signals: case study in Montserrat (Spain)

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After a rock fall, usual post event surveys include qualitative volume estimation, trajectory mapping and departing zones determination. However, any quantitative measurements are normally taken. Additional relevant quantitative information could help in determining the spatial occurrence of rock falls and help us in quantifying its size. Seismic measurements could be a good tool to provide this type of information. According to their characteristics, seismic measurements seem to be suitable for detection purposes, since they are non invasive methods and are relatively cheap. Moreover, they could bring important information regarding rock fall size and location of impacts.

The avalanche group of the University of Barcelona took advantage of the artificially released rock fall triggered in Montserrat the 14 of February of 2007 carried out to purge a slope to obtain the generated seismic data. The purpose was to asses if the exposed hypothesis is valid.

Two 3D seismic stations were deployed in the neighbouring area at around 200 m from the explosion point that triggered the rock fall. The initial volume of the rock was estimated from the analysis of data obtained with a subsequent laser scanning of the wall, to be 75 m^3. After the explosion dozens of boulders ranging from 10^{-4} to 1 m^3 impacted into the ground at different places. The maximum block size was

estimated from the deposits to be 5 m^3. The blocks felt down into a terrace 120 m below the release zone. The impact generated a small continuous mass movement composed by a mixture of rocks, sand and dust that run down the slope and impacted into the road 60 m below. Some boulders were not retained by the dynamic barriers previously installed in the area and run downhill approximately 200 m following the channel.

The seismic records obtained at the seismic stations were analyzed. Time, Time-Frequency evolution and particle movement analysis were performed in order to provide information on the suitability of seismic methods for rock falls detection, location, and size determination. The obtained results indicate that:

1- Rock fall generated seismic signals shows specific characteristic in the time domain

2- The mass movement generated seismic signals show different Time-Frequency evolution than other seismogenic sources (e.g. earthquakes, explosions or a punctual rock impacts). This feature could be used for detection purposes.

3- Polarization analysis indicates that generated seismic signals are mainly composed by primary waves and surface waves (Rayleigh)

4- Particle motion plots analysis show that rock impact location procedure based on two stations is feasible.

5- Seismic energy estimations show that the quantity of potential energy converted to seismic waves is very small highlighting the high non linearity of the process.

The Spanish "Ministerio de Educación y Ciencia" supported this research through

Projects CGL2006-06596/BTE and HU-2007-11