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On the location of microseismic sources in instable rock slope areas: heterogeneous vs. homogenous 3D velocity models

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Rock-falls are one of the most common and hazardous phenomena occurring in mountainous areas. The formation of cracks in rocks is often accompanied by a sudden release of energy, which propagates in form of elastic waves and can be detected by a suitable transducer array. Therefore, geophones are among the most effective monitoring devices to investigate eventual precursors of rock-fall phenomena. However, the identification of an efficient procedure to forecast rock-fall occurrence in space and time is still an open challenge.
In this study, we aim at developing an efficient procedure to locate microseismic sources relevant to cracking mechanisms, and thus gather indications on eventual precursors of rock-fall phenomena. Common seismic location tools usually implement homogeneous or multilayered velocity models but, in case of high slope gradients and heavily fractured rock masses, these simplifications may lead to errors on the correct estimation of the source location. Thus, we analyzed how the consideration of 3D material properties on the propagation medium may influence the location. In the framework of the Alcotra 2007-2013 Project MASSA (Medium And Small Size rock-fall hazard Assessment), a monitoring system composed by 8 triaxial geophones was installed in 2010 at the J.A. Carrel hut (3829 m a.s.l., Matterhorn, NW Italian Alps) and during the first year of operation the network recorded more than 600 natural events that exceeded a fixed threshold [1]. Despite the harsh environmental conditions of the study area, eighteen points distributed as uniformly as possible in space were selected for hammering. The artificial source dataset of known coordinates was used to constrain a 3D heterogeneous velocity model through a Simultaneous Iterative Reconstructive Technique. In order to mitigate the intrinsic uncertainties of the inversion procedure, bootstrapping was performed to extend the dataset and a statistical analysis was issued to improve the model reliability. Preliminary results show a relevant improvement by considering a more realistic 3D heterogeneous velocity model for the relocation of seismic recordings due to artificial sources with respect to a homogeneous one. Future work will focus on the evaluation of the efficiency of the here presented 3D velocity model for the location of natural microseismic sources.

[1] Occhiena, C., Coviello, V., Arattano, M., Chiarle, M., Morra di Cella, U., Pirulli, M., Pogliotti, P., and Scavia, C.: Analysis of microseismic signals and temperature recordings for rock slope stability investigations in high mountain areas, Nat. Hazards Earth Syst. Sci., 12, 2283-2298, doi:10.5194/nhess-12-2283-2012, 2012.