Geophysical Research Abstracts,
Vol. 11, EGU2009-10663-2, 2009
EGU General Assembly 2009

Structural and geomechanical pattern recognition using terrestrial and airborne laser scanner techniques

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Terrestrial laser scanner (TLS) and aerial laser scanner (ALS) techniques are nowadays fundamental tools in rock instability assessment, since they provide detailed, homogeneous and accurate data in a remote way, allowing fast and safe surveys. As demonstrated in this study, the combination of TLS- and ALS-based data provides a multi-scale picture which enables an analysis of the tectonic influence on local rock instability phenomena.
The study site is the Cinque Torri group placed in Eastern Dolomites (Italy), an internationally well known touristic place with an extension of 41.000 m square, constituted by 12 pinnacles (a 13th pinnacle collapsed in 2004) characterized by frequent rock falls mainly induced by deep ground deformation and rock weathering. TLS and ALS data were combined in order to obtain a complete information, respectively on steep and planar surfaces. In particular, an area of about 3.5 km square was considered in ALS acquisition.
The calcareous lithology constituting the Cinque Torri group is broken up by different systems of sub-vertical conjugated faults or fractures related to Mesozoic-Cenozoic tectonics. Since the discontinuities strongly influence the behaviour of a rock mass, their recognition and characterization are necessary in hazard assessment of rock cliffs instabilities and in numerical stability analysis. In order to obtain spatial distribution of discontinuities, Coltop-3D software was applied. Such a recently developed package is able to perform a detailed structural analysis starting from the original point cloud. Basically, the spatial orientation of each 3D point and its neighbours is computed through the automatic processing of dip angle and dip direction of the associated fitted plane. The poles of the recognized planes are then plotted in common stereo plots and grouped into joint sets to allow the comparison between regional and local tectonic.
In this study a common trend among the specific joint sets was found, even if the local discontinuities inside the studied group, compared to the regional trend, show a general rotation. This difference from the regional trend provides a kinematic description of the general movement of the Cinque Torri group, that can be interpreted as initially tectonic controlled with a subsequent anticlockwise rotation, mainly induced by deep ground deformation. Particular interest consists on the accuracy and time effectiveness of this methodology in the recognition of the relations among structural, lithological and geomorphological components of the Cinque Torri rock instability.