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A new method to derive rotational components of recent lateral spreadings: a laser scanning application

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In order to deal with recent and active gravitational phenomena, it is important to solve the present behavior of the instability both in terms of geometry and kinematics. Multi-temporal laser scanner data are useful for this purpose since they provide a detailed and accurate topographic model of the unstable rock mass and a statistically robust kinematic record of the present movements.
A crucial issue is the identification of the past movements to reconstruct a model able to explain the causes that triggered and fed the gravitational phenomena.
In this frame the present work aims to offer a novel methodology to investigate past lateral spreading movements occurred inside a gravitational body by means of rock discontinuities analysis. To accomplish this target, a single multi-scale acquisition of the landslide as well as of their stable surroundings is required.
More in details the methodology is based on: i) automated collection of geometric data by means of laser scanner techniques, ii) structural semi-automated back analysis based on recognition of the common discontinuity sets among rotated rock elements and definition of a reference frame for each set in correspondence of stable external areas, iii) computation of the occurred 3D rotations in terms of Euler angles by means of MATLAB scripts to describe the present settlement of the rock mass system with respect to the surrounding stable areas.
The studied instability phenomena of the Cinque Torri group (Eastern Alps- Italy) represents an example of lateral spreading developed on a larger Deep Seated Gravitational Slope Deformation (DSGSD) area. After the recent fall of a monolith of more than 104 m3, a scientific program began in order to monitor the more unstable sectors and characterize the past movements.
In June 2008, the Cinque Torri rock group was observed by using a long-range terrestrial laser scanner (TLS) and an aerial laser scanner (ALS). The survey was performed covering $\sim$3.5 km2 area. Together with the laser scanner acquisitions, a supporting GPS campaign was carried out for data registration/georeferencing purposes.
The results of the proposed methodology allowed a primary identification of the tectonic fabric on the spread rock sectors in terms of representativeness of joint families inside the group with respect to the external stable areas. Both bedding planes and representative joint-sets were used to derive the Euler angles that describe the rotational components of the lateral spreading. On these basis a new interpretation of the phenomena has been achieved.
Surprisingly the bedding plane attitude seems to have a limited influence on the kinematics of the ongoing spreading process since the rotation angles and versus are very inhomogeneous and in general do not show clear trends along or across the strata dip direction. In addition, the results suggest a rotational component of the movement, and a probable compound sliding surface.