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Displacements mapping and rockfall volumes calculation using Terrestrial Laser Scanner: toward an hazard assessment of the Preonzo rockslide

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Large rock-collapses represent a main treat for alpine communities situated close to steep slopes. The detection of potential large collapses requires the identification of pre-failure displacements and thus the characterization of rockfall activity as well as the investigation of the predisposing and triggering factors.
The Preonzo rockslide is located about 1 km away of the actual village of Preonzo, in the southern Swiss Alps, 10 km north of the city of Bellinzona (Switzerland). The instability is located close to a main tectonic boundary separating the Simano and the Leventina nappes of the Penninic domain. The upper part of the scar is composed of orthogneiss and amphibolite and the lower part consists of layered gneisses. In between the upper and the lower parts, there is a 60 m thick layer of weak and very fractured schists.
Historical texts report rockfall activity since year 1700 and in february 1702 a large rockfall event is suspected to have partly buried the old village of Preonzo. In May 2000 and during spring 2001 several rockfalls occurred and the 08 May 2002 a large collapse of about 120'000 m3 happened, after a heavy rain period. A large tension crack opened 90 m beside the main scarp which isolated a potential unstable volume of about 700'000 m3. In May 2010 another activity period of two weeks led to a 30'000 m3 event. At present-day the largest collapse ever recorded occurred the 15 May 2012 with a calculated volume of about 220'000 m3.
Accurate monitoring (mainly extensometers and geodetic surveys) is settled in Preonzo rockslide since 1991 and monthly acquisition of accurate (point-to-point spacing of 0.07 m) Terrestrial Laser Scanning (TLS) point clouds is performed since the main event of 2012. The 2012 rockmass displacements have been quantified and the rockfall volumes calculated. A particular attention has been given to the mapping of the geologic limits which was mainly performed using Terrestrial Laser Scanning (TLS) point cloud. The differentiation of the rocks is obtained based on the intensity value associated to each point of the TLS point cloud. Validation was performed with existing literature, field observations and high resolution pictures. An extensive structural analysis was performed, coupling TLS point clouds and field investigations to define the orientation and the geometrical characteristics of the main discontinuity sets. Four main joint sets have been highlighted as well as their relevance in the development of the recent failures. Multiples wedge structures affect the stability of the cliff as well as a steeply dipping discontinuity set parallel to the tension cracks existing beside the main scarp.