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Analyses of a rock fall release area and associated deposits in the Swiss Alps using photogrammetric data obtained by an Unmanned Aerial Vehicle

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Unmanned Aerial Vehicles (UAVs) are ideal tools for conducting local aerial photogrammetry. Using *off-the-shelf* processing software packages a wide range of analyses can be carried out, such as Digital Elevation Model (DEM) and orthophoto calculation, detection of motion and extraction of, e.g., rock mass structural data used for the detection and characterization of rock slope instabilities.

The crystalline rock mass of the upper Aar valley in southcentral Switzerland (known as Grimsel region) is dissected by Pleistocene exfoliation (sheeting) joints [1]. These joints are restricted to the uppermost 200 m below ground and occur as fracture sets subparallel to current and palaeo bedrock surfaces. Exfoliation joint sets contribute to slope instabilities, such as rock falls and rock slides. Within the framework of investigating the impact of exfoliation joints on recent rock fall activity in the upper Aar valley – one of the last rock falls happened on April 20th 2013 and reached the main road and a parking area – we conducted a photogrammetric survey in 2015 of the steep (>50°) rock slope and rock fall deposits using a UAV (Figure 1A). About 280 photographs at 110–250 m above ground and at a horizontal distance of 150–250 m to the target rock slope, covering an area of 0.4 km², were taken with a standard digital camera with 19 mm fixed-focus lens at 24 megapixel. A 8-cm resolution DEM and 4-cm resolution orthophotos were calculated using *structure-from-motion* technology and GPS ground control points (see example data and comparison with existing data in Figure 1B-E).

We aim at showing: 1) structural and kinematic analyses of the failed rock mass focusing on the impact of exfoliation joints; and 2) a detailed investigation of the rock fall debris using orthophoto and field data from before and after the event and by analysing the changes in ground surface elevation.

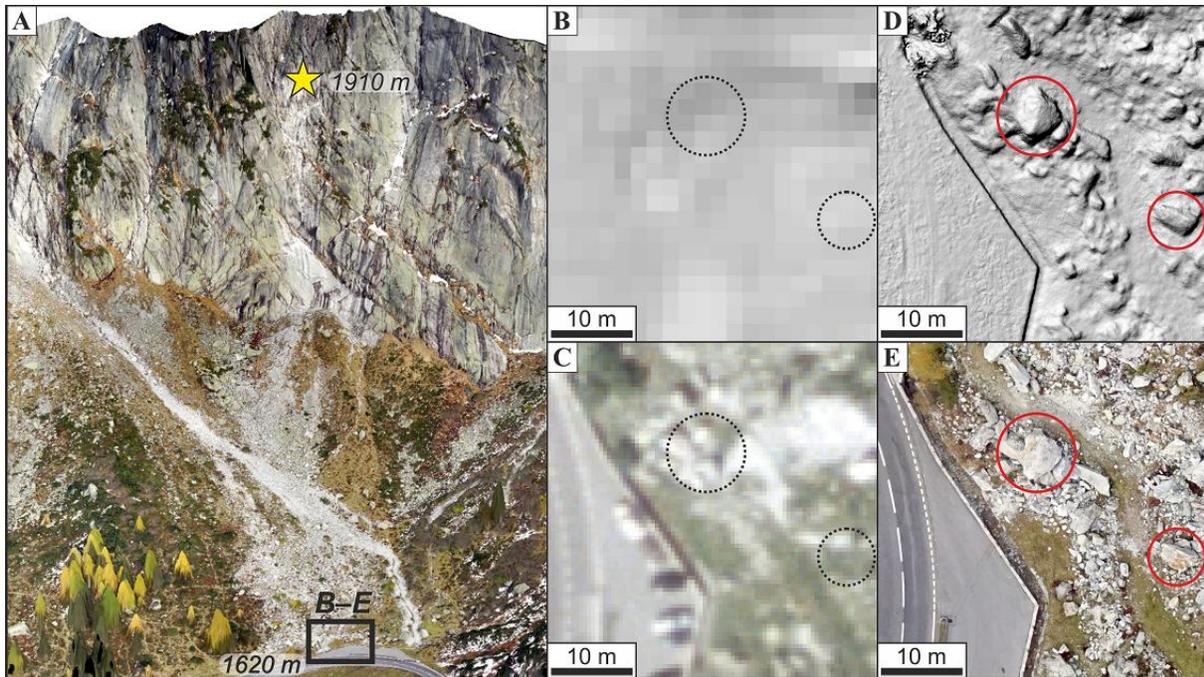


Figure 1: A) Perspective view of the 2013 rock fall location (new photogrammetric surface model). The release area is marked by the yellow star. B) 2-m DEM hillshade (swissALTI3D, swisstopo). C) 0.5-m orthophoto from 2008 (swisstopo). D) 8-cm DEM hillshade (2015). E) 4-cm orthophoto (2015). Red circles highlight two blocks from the 2013 rock fall event close to the Grimsel road.

Reference:

[1] Ziegler M et al. (2013) *Geomorphology* 201: 344-362

