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Quantyfiying boulder covers on caprock-crowned hillslopes – a means to decipher the patterns of escarpment retreat?

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Rock materials on slope surfaces, derived from upslope segments and transported by gravity, are a carrier of important geomorphic information. They can be causally linked to processes operating on hillslopes and hence, help to recognize mechanisms involved in slope retreat and lowering, related to both weathering and mass movements. Moreover, these materials and landforms built of them are part of the memory of a hillslope geomorphic system and allow us to infer past events, such as transport mechanisms that are no longer operating. In this way, pathways of slope evolution over time can be reconstructed, and differences between neighbouring slope segments be evaluated.

Only a few studies have attempted to explain the origin of boulder mantles in tablelands, where they usually occur on the sub-caprock slopes. These mantles were variously hypothesized to result from rockfalls, toppling, landslides or in situ disintegration. There have hardly been any studies focussing on the quantification of such boulder mantles. This stands in contrast to the voluminous literature on scree where an informal protocol how to characterize these deposits exists and various morphometric features of scree slopes are used to infer processes involved in their built-up and re-modelling.

In this study, our primary intention is to develop a set of approaches and indices which would help to characterize boulder mantles quantitatively and more objectively, opening the way to comparative studies based on a common protocol. They are based on field observations and measurements, as well as on geomorphometric analyses of high-resolution (1 m × 1 m) LiDAR DEMs. The study focuses on two localities; on boulder-mantled hillslopes of two sandstone-capped mesas in Central Europe, the Szczeliniec Wielki in south-west Poland and Pfaffenstein in east Germany. Additionally, sandstone samples were collected from boulders and the adjacent cliff-lines at Szczeliniec Wielki for dating purposes (exposure dating using cosmogenic ^{10}Be). In this case, the goal was to identify whether the exposure ages of boulder-covers follow any patterns in the downslope direction, which might be interpreted in terms of involved geomorphic processes.

The results show that derivatives of airborne LiDAR DEMs can be a useful source of information, allowing to study the patterns of boulder distribution within the sub-caprock slopes. Yet, it is strongly recommended to precede any morphometric analyses by field reconnaissance and semi-manual DEM upgrades on the basis of point cloud data as it turned out that automatic filtration algorithms removed a large amount of boulders, resulting in a picture that does not reflect the

actual morphological situation. With the issue of DEM quality being solved, surface roughness indices enable overall quantification of spatial distribution of boulders. It should be underlined, however, that field measurements across slope longitudinal profiles are of considerable added value, helping to determine the azimuth of boulders' longer axis or the details of boulder dimensions. This information, together with DEM-based analysis, can be used to hypothesize processes that are involved in boulder accumulation and their diversity in space.

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