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Rock glacier sediment, kinematics and geomorphometry: a study case from the Eastern Italian Alps

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Rock glaciers are important geomorphological structures of high mountain environments and fundamental indicators for permafrost. They consist of unconsolidated rock debris – generally derived from talus or till - held together by ice, moving slowly downslope due to the gravitation in combination with uncountable freeze-thaw-cycles in the active layer. The downslope movement of rock glaciers leads to lobate structures with depressed areas as well as ridges where the sediments tend to accumulate, creating a typical surface morphology defined as "ridges and furrows". This study focuses on the analysis of one rock glacier system located in the Pfitsch/Vizze valley (South Tyrol), in the Eastern Italian Alps. The debris in this area comprises exclusively the granitic Central Gneiss of the Tauern window. Rock glacier sediment derives from talus, consisting essentially of more or less foliated to planar angular material, which was essentially formed by frost weathering. The size and shape of sediments present at the surface of the rock glacier system were analyzed in correlation with displacement and geomorphometry, with the hypothesis that sediments shape and size at different sites across the rock glacier might relate to its past and present dynamics. The displacement analyses were carried out to quantify rock glaciers movements during the last 20 years, and the geomorphometrical characteristics were investigated to identify specific geometrical attributes that may be linked to internal ice changes.
Clasts analysis showed how rock glacier sediments are very heterogeneous, with dimensions being mainly determined by transport distance, and sphericity and roundness by lithology. A role of sediments characteristics on displacement rate did not turn out evident. Convexities and concavities observed on the study site are apparently created respectively by the accumulation of sediments and the collapse of the structure due to the internal ice melting. Indeed, the recent, marked increase in air temperature observed in the last decades in the Alps has likely caused an accelerated ice melting in the less protected – in terms of solar radiation – rock glaciers, as is the case for our study area. Sediments here are no longer bound by ice and have become rather unstable. Therefore, the monitoring of rock glaciers is fundamental to anticipate future changes in the type and magnitude of natural hazards originating at high elevations, as thicker layers of sediments are becoming increasingly unstable.