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Age and debris transport capacity of creeping mountain permafrost features - a quantitative study from the Swiss Alps

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Rockglaciers - features of creeping mountain permafrost - are periglacial debris accumulations produced, deposited, and deformed during timescales of centuries to millenia. They are important parts of the mass movement system in mountainous areas. They creep downslope with velocities in the order of cm to dm per year, and despite this slow movement, they are comparably efficient debris transport agents. In the present study, we investigate the age of selected rockglaciers and mass accumulation and relocation by active rockglaciers in a small study site in the Eastern Swiss Alps, in order to analyse the debris transport capacity of rockglaciers over millennia.

Rockglacier ages were determined for 32 relict rockglaciers (using temperature reconstructions and geomorphological cross-validation with dated moraines) and 6 active rockglaciers (using photogrammetrical streamline calculations). The results indicate that the investigated relict rockglaciers date back to the Younger Dryas (20 of 32 investigated features) and to the early Holocene (12 of 32 investigated features) and that the minimum age of the 6 active rockglaciers is between 3 and 5 ka. This implies that these active rockglaciers began to evolve during the early Holocene or, at the latest, after the end of the Holocene temperature optimum (approx. 5000 y BP). Taken together, the ages of the relict and the active rockglaciers show that the study region was partly characterized by glacier-free permafrost areas since the Younger Dryas.

Debris transport capacity was calculated by means of numerical modelling and inclusion of empirical data. The study site for the modelling is 6 x 6 km large and comprises 29 rockglaciers and protalus rampart, 12 of which are active, 13 inactive and 4 relict. The total amount of rockglacier material accumulated after one model run in our test site adds up to 3.1*10ˆ8 m3 of material over 10’000 years. Taking into account an

average density of rockglacier material (1.5 g/cm3) and typical values for ice content by volume of active rockglaciers (50 to 90%) yields a total accumulation of debris (without ice) in the study area of 4.6*10ˆ3 t/year to 2.3*10ˆ4 t/year.