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Discharge dynamics of a relict rock glacier in a crystalline catchment in the Seckauer Tauern, Austria

M. Pauritsch (1), A. Kellerer-Pirklbauer (1,2), S. Birk (1), and G. Winkler (1)

(1) Department of Earth Sciences, University of Graz, Austria, (2) Institute of Remote Sensing and Photogrammetry, Graz University of Technology, Austria; marcus.pauritsch@uni-graz.at

The discharge dynamics of rock glaciers is still poorly understood. In particular studies about springs of relict rock glaciers are rare. However, particularly in crystalline mountain regions (relict) rock glaciers form important aquifers drained by springs with discharge up to several tens of litres. Thus, they are essential for the local ecology and can be used for drinking water supply or hydroelectric power production. This study focuses on the relict Schöneben Rock Glacier in the Seckauer Tauern Range, Austria (E14°40'26", N47°22'31"). The relict rock glacier covers an area of 0.11 km^2 extending between 1720 and 1905 m a.s.l.. It consists predominantly of coarse-grained gneissic sediments and is covered with blocks up to a size of several cubic metres. The entire spring catchment, including the relict rock glacier, covers 0.76 km^2 with a maximum elevation of 2282 m a.s.l.. The discharge of the rock glacier spring has been recorded since 2002. Furthermore, electrical conductivity and water temperature have been recorded since 2008. These data were used to analyse the recession behaviour of the spring, to separate the discharge components and to characterize the hydraulic aquifer properties. Furthermore, a tracer test with simultaneous injection of the fluorescent dyes naphtionate and fluorescein at two injection points (one close to the front and one close to the rooting zone of the rock glacier) was conducted in order to obtain information about the travel times of the water through the rock glacier. The observed spring hydrograph exhibits a slow base flow recession but sharp discharge peaks after rainfall events comparable to karst aquifers. This similarity is also indicated by the electrical conductivity and temperature of the spring water responding strongly and only slightly delayed after the rise in discharge. The spring hydrograph can be decomposed in three exponential recession functions with different recession coefficients depending on the range of discharge: (a) discharge >40 l/s α=0.2-0.07 [1/d], (b) discharge 10-40 l/s α=0.07-0.03 [1/d], (c) discharge <10 l/s α=0.02-0.006 [1/d]. In the artificial tracer experiment, the peak of the fluorescein breakthrough curve was observed between 79 and 108 days after the tracer injection, which agrees well with the (reciprocal of the) recession coefficient of the base flow (α=0.02-0.006 [1/d] corresponding to a response time of 50-167 days). Naphtionate, which was injected close to the front, was not detected during an observation period of 6 months. As opposed to the long travel times of the artificial tracers, the hydrograph separation based on the electrical conductivity of the spring water reveals that soon (approximately 3 hours) after the rise in discharge a significant portion (up to 50 %) of the discharging water originates from rapid recharge. The water temperature shows a sharp negative peak after recharge events, which might indicate some small remaining permafrost bodies in the rock glacier. A first conceptual model of the relict rock glacier assumes a coarse-grained mantle with high hydraulic conductivity, capable to transport the rapid recharge and a core with lower hydraulic conductivity, resulting in a slow base flow recession.