Relict rock glaciers- complex aquifer systems in alpine catchments, Niedere Tauern Range, Austria

Pauritsch, M.[1], Winkler, G.[1], Kellerer-Pirklbauer, A.[1,2], Birk, S.[1]

[1] Institute for Earth Sciences, University of Graz, Austria
(marcus.pauritsch@uni-graz.at)
[2] Department of Geography and Regional Science, University of Graz, Austria

In the 1990s water resources investigations in the Niederen Tauern Range, Austria demonstrated that springs draining relict rock glaciers are of importance for water supply and human consumption as well as for the alpine ecosystem. Recent studies show that in the easternmost subunit of this mountain range, the Seckauer Tauern Range, up to 20% of the area above 1500 m a.s.l. and more than 40% of the area above 2000 m a.s.l. drain through relict rock glaciers. Thus, the hydraulic properties of these alpine aquifers are considered to have an important impact on the hydrology of the region. Their storage capacity affects and regulates strongly the risk of natural hazards such as floods and debris flows and the possibility for economic use of the water resources. However, the hydraulic properties of relict rock glaciers and their inner structure are still poorly understood.

The investigation area is the Schöneben Rock Glacier (SRG) located in the central part of the Seckauer Tauern Range. The SRG cover consists predominantly of coarse-grained, blocky gneissic sediments and extends from 1720 to 1905 m a.s.l.. It covers an area of 0.11 km² and drains a total catchment of 0.76 km² with its maximum elevation of 2282 m a.s.l.. Discharge of the rock glacier spring is recorded since 2002. Natural tracers, electrical conductivity and water temperature are continuously monitored since 2008. Furthermore, a tracer test with simultaneous injection of the fluorescent dyes naphthionate and uranine at two injection points (one close to the front and one close to the rooting zone of the rock glacier) was performed. The analysis of the spring hydrograph on the one hand shows a slow base flow recession indicating a high storage capacity and on the other hand sharp discharge peaks immediately after rainfall events referring to a high hydraulic conductivity. The spring hydrograph therefore reveals similarities to the flow dynamics of karst springs. Results from analytical recession models are consistent with the conceptual model of a heterogeneous aquifer that is composed of multiple overlapping exponential segments with recession coefficients ranging from 0.06 to 0.002 d-1. The peak of the uranine breakthrough curve was recorded after approximately 100 days. This agrees well with the reciprocal of the intermediate recession coefficient, which may be interpreted as the mean residence time of the corresponding flow component. In addition to this intermediate flow component, the rapid spring responses to recharge events with sharp discharge peaks and negative electric conductivity and temperature peaks within a few hours suggest the existence of a fast flow component. Using electrical conductivity to separate the discharge components of the hydrograph yields up to 20% event water with residence times in the order of hours whereas 80% of the discharge is found to be pre-event water with longer residence times. The highest percentage of event water coincides with the highest discharge rates. The natural and artificial tracers thus support the conceptual model of a heterogeneous aquifer with at least two different storage components. While a coarse grained, blocky upper zone is believed to provide the fast run off component, a fine grained (sandy, poorly silty although with larger embedded blocks) inner zone provides the base flow component.

Acknowledgments: This project is co-funded by the European Regional Development Fund (ERDF) and the Federal Province of Styria, funding program "Investionen in Ihre Zukunft". Project homepage: http://www.uni-graz.at/hydro-blogle.