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Karst infiltration zone in a nivo-glacial setting: hydrological aspects and dissolution rates (Ventennale cave, Italian Alps)

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Continuous monitoring of discharge (Q), temperature (T) and electrical conductivity (EC) of a rivulet flowing within Grotta del Ventennale cave (elevation 2430 m a.s.l., Brenta Dolomites, Italian Alps) shows typical nivo-glacial hydrology: very low Q, stable T and EC in winter, trending toward asymptotic values (Q = 0.02 L s^{-1}; T = 1.5˚C; EC_{20} = 128 μS cm^{-1}), and high Q, lower T and EC from May to October.

Given the scarce or completely absent soil cover, and a very limited epikarst development, the cave rivulet is extremely sensitive to recharge, and also minor precipitation events are recorded with very short time lag ($<$ 0.5 h). Moreover, the thin rock overburden ($<$ 50 m) and the highly karstified dolomite rock yields negligible memory and piston effects. It is possible, therefore, to study in detail the hydrology and dissolution mechanisms of this karst system.

Throughout the snowmelt, T, EC and Q show strong daily sinusoidal fluctuations from the average values up to $\pm$25 μS cm^{-1} for EC, up to $\pm$0.1˚C for T and between +100% and –50% for Q. The cycles, however, are not synchronous with the external air temperature daily cycles, but display offsets which vary from 8 hours in late April to 2 hours in late June, when most of the snow cover is melted. This phenomenon reflects the time span from when the meltwater crosses the 3 to 1 m-thick snow pack above the cave to when it actually reaches the cave rivulet.

By the study of the recession curves of unimodal precipitation events it was possible to precisely describe the residence time of the water as an inverse power function of the discharge. The EC, in turn, during the snowmelt and the major summer precipitation events is related with an inverse power function to the discharge and the residence

time. By analyzing selected time-periods it is possible to identify different regression curves, calculate the dissolution rates and the EC near-asymptotic values corresponding to a residence time of 1 month, when the dissolution rates for Ca + Mg are below 0.002 meq d^{-1}. These values range from 124 μS cm^{-1} in winter-spring up to 146 μS cm^{-1} recorded in August-September, and reflect the limited soil CO_2 contribution to the system during the summer months. This implies that the slower dissolution kinetics of the meltwater allow prolonged reaction that can cause the karstification in the deeper parts of the aquifer.

These observations are confirmed by the frequency analysis that reveal a bimodal distribution of EC with a primary peak (126 μS cm^{-1} = 30%) corresponding to the winter-spring months and a secondary peak (140 μS cm^{-1} = 11%) which corresponds to the late summer.