Karst hydrology, geochemistry and dissolution rates in an Alpine dolomitic catchment (Brenta Dolomites, Italy)

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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, 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 (Dolomia Principale, Upper Triassic) 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 of the cave rivulet show strong daily sinusoidal fluctuations from the average values up to ±25 $\mu S\ cm^{-1}$ for EC, up to ±0.1°C for T and between +100 % and –50 % for Q.

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 vary between 0.002 and 0.00005 meq d^{-1}. These values range from 124 $\mu S\ cm^{-1}$ in winter-spring up to 146 $\mu S\ cm^{-1}$ 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.

The cave waters are drained by the Vallesinella springs (elevation 1560 m a.s.l), a group of karstic springs with a catchment of 12 km^2 and a mean annual discharge of 400 $l\ s^{-1}$ located 4 km along the valley bottom. Vallesinella are typical Alpine karstic springs displaying clear piston effects lasting several hours.

The EC values of the springs fluctuate from 100-130 $\mu S\ cm^{-1}$ during the snowmelt (May-August) up to the asymptotic values of 185 $\mu S\ cm^{-1}$ recorded in early Spring. These higher EC values reflect the prolonged residence time, and the mixing of waters infiltrated at different elevation, i.e. with a different dissolved CO_2 load.

The residence time in the aquifer is ruled by the springs discharge, and chemical analyses over a two-year period reveal a strong negative correlation between Q and the carbonate-related variables such as EC, Ca, HCO_3, SO_4, saturation for Mg and Ca and the Mg/Ca ratio.