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Chemical erosion and dissolved load of a calcareous torrential catchment in the northern Alps

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Studies on fluvial erosion often focus on the solid load, while the solute load receives less attention. However, chemical weathering and denudation contribute significantly to the mass redistribution and landscape evolution, especially in carbonate regions. In this study we present a chemical denudation rate for the 50 km² sized Taugl catchment in the Northern Calcareous Alps. The catchment is predominantly covered by the bedded carbonates of the Oberalm-Formation.
To determine the chemical denudation rates for the Taugl catchment, we installed a probe at the riverbank to record water level, conductivity and temperature. Additionally, we performed discharge measurements using a current meter, which were used in combination with the measured water level to create a rating curve. Water samples were collected at different runoff conditions and analysed by ion chromatography. The hydrogen carbonate samples were titrated using an automatic titrator. These analyses enabled the determination of the correlation between the ion concentration and the electric conductivity and its integration over time.
During the study period (2021/08/20 – 2023/11/23), the total discharge was 1.16 x 10^8 m³. The measured water levels varied between 0.48 m and 3.23 m and the conductivity ranged from 82 µS/cm to 245 µS/cm. The analysis of the water composition shows a dominance of Ca2+ (89.7 %) followed by Mg2+ (4.3 %) among the cations and HCO3- (95.0 %) among anions. The cation concentrations was then converted into their rock equivalents and interpolated over the gauging period.
An estimated sum of 9.8 x 103 t of carbonate rock is transported out of the catchment during the study period, representing a total volume of 3600 m3. This results in a chemical denudation rate of 71 µm (0,071 mm) for the 27-month period. Considering that the annual precipitation sums of 2021 (1490 mm), 2022 (1500 mm) and 2023 (1609 mm) are below the long-term annual mean (1700 mm) and that the wet spring in 2021 was not measured, an annual denudation rate of at least 32 µm/a (0.03 mm /a or 30 m / Ma) is proposed. This aligns with the results of prior studies in similar regions and is of the same order of magnitude as the catchment-wide erosion rates determined by the concentration of cosmogenic nuclides in crystalline low mountain ranges such as the Bohemian Massif. Our findings emphasize the relevance of chemical erosion in carbonate-dominated catchments.

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