

Chemical denudation rates of a small torrential catchment in the Northern Calcareous Alps

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Our understanding on the decay of alpine landscapes and the pace of landscape adjustment to climatic or tectonic changes rely on catchment wide erosion rates. In general, these data stem from cosmogenic isotope dating of quartz grains and are therefore only applicable at catchments providing suitable bedrock. However, denudation caused by the dissolution of rocks is not explicitly considered by this method. In the Northern Calcareous Alps (NCA) crystalline rocks are missing and intensive karstification suggests that chemical denudation is an important player for destroying topography.

In this study we present chemical denudation rates derived from measuring the dissolved load of an alpine catchment located in the country of Salzburg, Austria. The catchment has a drainage area of about 7 km^2 and is predominantly covered by limestone rich glacial deposits and carbonatic rocks as characteristic for the NCA. In order to obtain catchment wide chemical denudation rates we have integrated discharge time series that were measured by a permanent water gauge of the Austrian Service for Torrent and Avalanche Control to compute the total discharge of the investigated catchment over a period of one year. During the same period samples were taken at several campaigns to consider variations of the dissolved load. Samples were taken at high and low run-off conditions to study the effect of precipitation and at different locations along the tributaries to account for lithological variations of the river beds on the dissolved load. The concentrations of various cations in water samples were measured by the ICP-MS facility at the University of Graz.

For the investigation period of one year $3.02 * 10^6 \text{ m}^3$ of discharge was measured at the catchment outlet. The summed cation-concentration is varying between about 85 mg/l for dry-conditions and 75 mg/l for rainy-conditions at the gauge and consists predominantly of Ca^+ cations. Based on the total discharge of the river integrated over a period of one year and the average dissolved load determined from water samples by the ICP-MS measurements, we obtained a total dissolved load of $495 \text{ t/year CaCO}_3$ equivalent. Here, the CaCO_3 amount was grossed up on the basis of the averaged Ca^+ concentration. This leads to a chemical denudation rate of 0.06 mm/year , which is about one order of magnitude lower compared to mechanical denudation rates reported from steep alpine catchments determined by cosmogenic isotope dating. The results imply that chemical denudation is a significant driver for redistributing mass in alpine catchments as long as the river bed consists of carbonatic rocks and might be the dominant erosional process in such settings. The dissolved load is redistributed by the drainage system from high alpine domains towards the oceans and is supposed to play a more important role than expected.