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Deep chemical weathering in a rapidly eroding mountain belt, Taiwan

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Chemical weathering constitutes a principal component of the carbon cycle and a long-term control on global climate. River chemistry offers integrated information on weathering processes and their location within a river basin and its substrate. As such, it combines the contributions moderated by surface processes including erosion, sediment production and soil formation with weathering fluxes from deeper levels in the underlying bedrock. Analysis of a 7-yr time series of river water samples from the Liwu River, Taiwan, has allowed us to identify three distinct water reservoirs whose contribution to river load depends on rainfall and discharge. This is a classical feature of the hydrology of bedrock catchments, but the chemical data highlight the changing contributions from surface, shallow and deeper groundwater sources. Deep weathering, within the bedrock, is a dominant contribution to river load for 75% of time, mainly at low discharges. These low discharges convey 40% of the annual water flux and around 45-50% of the total chemical weathering flux. At higher discharges, weathering contributions from surface and shallow sources become dominant but deeper groundwater still contributes significantly to the riverine dissolved load. Due to its longer residence time, the fraction of the chemical load derived from silicate weathering is higher in the deep groundwaters. These are therefore an important component in the silicate weathering feedback that moderates climate on long time scales, even in high rainfall, rapidly eroding, catchments such as in Taiwan. This implies that the weathering processes in the soil zone and shallow bedrock only provide part of the dissolved load and studies on the mechanisms and controls on weathering must take into account the processes which occur deeper in the bedrock.