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Relationship between chemical weathering and physical erosion in the Critical Zone: The case study of La Réunion

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Erosion produces fresh rock surfaces, promoting atmospheric CO_2 consumption by enhancing chemical weathering. Therefore, it is important to understand the couple relationship between physical erosion and chemical weathering for the study of global climate change.

La Réunion island, characterized by basalt composition, strong precipitation gradients and intense tropical storms, is a well-known hot spot of erosion and a natural laboratory to explore controls of intense physical erosion and chemical weathering rates. Here, we use stream water chemistry (1 to 6 samples per year during 14 years) and discharge time series to calculate the decennial chemical weathering rates of the main catchments across La Réunion. In order to get synchronous chemistry and discharge data, missing discharge data were filled from hydrological models (e.g. Rainfall-Runoff model, based on the relationship of discharge between two close hydrological stations). We find that the variation of chemical weathering rates over La Réunion cannot be explained by either runoff, annual mean precipitation or long-term total erosion rates. Instead, high chemical weathering rates are found in the Salazie catchment where large landslide deposits are well documented and cover at least 19.2% of the surface of the catchment. We investigate the stream water in Salazie, and we find that the water that flows through the landslide deposits has higher dissolved solids by up to a factor of ~6 than the water that passes through undisturbed basalt, demonstrating the impact of landslide deposits on chemical weathering. An effect of landslides on weathering has been documented in some mountain ranges (e.g. Taiwan) and mostly interpreted as enhanced sulfide weathering. Yet in La Réunion, sulfide minerals are not abundant and sulfate concentrations are more than ~15 times lower than the stream water in Taiwan. We propose the enhanced generation of available surface area in the landslide deposits on La Réunion promotes rapid chemical weathering and is sufficient to increase weathering fluxes across the entire catchment, with CO_2 being the dominant weathering agent.