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Spatial erosion variability and chemical weathering in a steep tropical catchment, La Réunion volcanic island

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Quantifying the respective contribution of chemical weathering and physical erosion in landscape dynamics has remained challenging. This is in part due to the intrinsic difference in spatial and temporal scales at which the various geomorphic processes operate. Tropical volcanic islands are small-scale settings, with spatially uniform bedrock lithology and a tropical humid climate offering a suitable setting for both intense chemical weathering and active erosion processes.

Here, we study the Langevin catchment (51 km2) located in La Réunion island (Indian ocean). The Langevin River is draining the southern flank of Piton de la Fournaise volcano, which has been active for the last 500 kyr with successive periods of volcanism/erosion before a last major eruptive event at ∼60-70 ka. Since then, the area has been perturbed by volcanic events of different magnitudes until very recent. The Langevin River is actively incising into lava bedrock, with high local relief along the valley (∼200-500 m) and very steep valley flanks prone to major collapses. We collected 7 bedrock samples in the river bed to date lavas emplacement (unspiked K-Ar dating) and quantify in-situ river incision rates (cosmogenic 3He analysis on olivine phenocrysts). In parallel, sand samples and dissolved/suspended loads have been collected along the river for both river geochemical mass-balance (major and trace elements contents) and quantification of catchment-integrated erosion rates from cosmogenic 3He concentrations.

Unspiked K-Ar dating suggests Holocene emplacement of lava flows (0-10 ka) that are presently incised by fluvial processes, confirmed by cosmogenic 3He exposure dating, which also show very low river incision rates (0.1-0.2 mm/yr). Cosmogenic 3He concentrations in sand samples show a high variability in catchment-integrated erosion rates (0.5-5 mm/yr), evidencing lateral input of fresh sediments from landslides. This is confirmed by the short-term erosion rates determined from geochemical mass balance. Future cosmogenic 3He analysis on different grain sizes from river sand samples will help to decipher the interplay between chemical weathering, landslide lateral input and river sediment transport in the catchment-integrated denudation budget along this steep tropical catchment.