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River dynamics and landscape evolution in La Réunion Island: insights from luminescence dating

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Tropical volcanic islands are natural laboratories to investigate the competition between volcanic construction (lava eruptions) and erosional destruction (extreme climatic events) in long-term landscape evolution. In La Réunion Island (Indian Ocean), the present day topography of the Piton des Neiges results from these competing processes. It presents three large-scale excavations called "cirques" that have been significantly eroded since the latest eruptive events but whose origin and formation time are still unclear. Indeed, the morphologic evolution of the Piton des Neiges is mostly known from K-Ar dating of lava flows and associated reconstructions of post-eruption eroded volumes. However, involved erosion processes and their rates through time remain poorly constrained, making it difficult to understand the geomorphic response to volcanic activity in this setting.

Here, we focus on the "Bras de Cilaos" river that drains the "Cilaos cirque" (southern part of the Piton des Neiges). The Cilaos cirque has been first excavated between 140-180 ka [1], and it has been filled again during a late-stage eruptive event at ∼145 ka [2] that also entirely filled the Bras de Cilaos valley. Alternatively, some studies have proposed that the Cilaos cirque and the Bras de Cilaos have been more recently filled by an eruption event at ∼70 ka [3]. The Bras de Cilaos river is characterized by high relief (400-650 m) with no remaining evidence for these late eruptive events, showing significant incision and efficient fluvial erosion/transport processes after lava emplacement. In its downstream part, it presents thick alluvial deposits preserved along its riverbanks. The presence of such deposits may provide important constraints on the river dynamics and especially its response to the latest eruption events. However this requires establishing a tight temporal framework for these sediment archives. We thus sampled five different sedimentary sequences along the river to date their deposition ages using Optically Stimulated Luminescence (OSL) on feldspar minerals, as well as on the volcanic groundmass. We also performed geochemical analyses to get some information about the sediment provenance.

Our geochemical results first reveal that all sedimentary samples come from a similar source which is an old volcanic massif (>340 ka) located at present at the bottom of the Cilaos cirque. This confirms the hypothesis that recent lava flows have been entirely eroded and evacuated towards the ocean by efficient river processes. Our luminescence results obtained on feldspars and groundmass aliquots suggest that all the investigated sedimentary sequences along the Bras de Cilaos were deposited during the late-Pleistocene period, at around 50-70 ka. This temporal framework allows to provide quantitative constraints on the geomorphic evolution of the Bras de Cilaos since ∼145 ka and to discuss how climatic changes and/or volcanic disturbance may have affected the river dynamics.

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