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Morphological evolution throughout the last 1.4 Myr of Piton des Neiges volcano (Réunion Island, Indian Ocean): competition between volcanic construction and erosion.

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Reunion Island (Indian Ocean) is a volcanic complex, whose eruptive history was dominated by the activity of two main edifices: Piton des Neiges (PN) and Piton de la Fournaise (PF) volcanoes. Tropical climate and associated heavy rainfalls induce erosion processes permanently competiting with constructional processes. Few geomorphological studies were carried out in the last decades on Reunion Island and erosive contributions have been strongly neglected in the morphostructural evolution models of Piton des Neiges, in favor of the giant landslide hypotheses. So, understanding its evolution requires discriminating between erosion and landsliding contributions acting on the volcano denudation. A geomorphological analysis, using a 50 m DEM, combined with new accurate K-Ar ages (Cassignol-Gillot technique), allow to draw the volcanological and geomorphological history of the emerged PN volcano, especially of its northeastern region. The arrangement of the different volcanological units reveals the presence of many large-scale relief inversions. 1Ma-old massifs are alternating with 600-400 ka-old massifs on the external part, whereas younger units are increasingly situated in the central area. This emphasizes the successive building stages with relief inversion from the periphery towards the central volcano area. The qualitative and quantitative geomorphological analyses allowed to 1) extract structural surface outflows (from preserved structural slopes), 2) compute their erosional state and 3) constrain the initial volcano shape. The eroded volumes have been calculated by substracting the present topography from the modeled surface of the PN topography. A minimum removed volume of 101 $\pm$ 44 km3 and 105 $\pm$ 41 km3 for the Mafate and Cilaos cirques, respectively, has been obtained. During the last 180 ka, the long-term erosion has induced the removal of at least 214 $\pm$ 62 km3, i.e. an average minimum erosion rate of 1.2 $\pm$ 0.4 km3/ka. This quantitative study demonstrates the high rates of erosional processes and the importance of global removed volume during the whole history of PN volcano (> 1000 km3). This volume is with the same order of magnitude as those involved in the debris avalanches deposits identified on the submarine flanks of the edifice. It therefore questioned the presence of major flank collapses younger than 1.4 Ma on the Piton des Neiges volcano. Although erosion has largely been neglected in the recent models, our study emphasizes it as a key component on landscape development and a major process in the morphological evolution of Reunion Island, rather than landslides.