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Evidence of flank failure deposit reactivation in a shield volcano. A favorable context for deep-seated landslide activation (La Réunion Island)

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Giant flank failures are recurrent features of shield volcanoes, and their deposits (i.e. breccia), constitute a significant volume in a volcanic edifice. On La Réunion Island, the growth and development of Piton des Neiges volcano has been punctuated by several flank failure episodes. One of these failures is a deep-seated landslide (>200 Mm3) occurring nowadays in Grand Ilet, a plateau inhabited by 1 000 people in the cirque of Salazie, on the northern flank of Piton des Neiges.

Here we present the results of a multidisciplinary study (structural geology and field mapping, GNSS monitoring, borehole logging) performed to characterize the geological structure the Grand Ilet landslide, and identify the instability factors that control this category of destabilization.

Basic breccia deposits, up to 160 meters thick, constitute the main geological formation of the unstable mass. This breccia are cut by the headwall scar of the landslide, and covered by lava flows, indicating a minimum age of 200 kyr for the destabilization that produced the deposits. The breccia is consolidated out of the landslide area. The NE toe of the landslide is evidenced by an important compressional deformation of the base of the breccia, and striated surfaces in this deformed volume indicate a NE-direction of transport. In this deformed bulge, a clay-rich layer at the base of the breccia has been identified as the main slip plane. Using a video inspection of drill casings on three exploration boreholes, we reconstructed the 3D geometry of the slip plane at the base of the breccia. This reconstruction shows that the landslide plane has an average dip of 6° toward the NE.

The displacement monitoring network shows that the unstable mass has a 5.5 km^2 extension, with a variable azimuth of movement direction (N140° for the SW sector, and N45° for the NE sector). The planimetric displacements velocities range between 2 cm/year in the inner part of the unstable mass to 52 cm/year at the landslide toe. The dip of displacement vectors vary from $34^\circ \pm 9$ uphill to $7^\circ \pm 2$ downhill near the landslide toe. This displacement field, the topography and the drill casings inspection show that secondary shear zones are located inside the landslide mass, characterized by a lower deformation rate than the basal shear zone. However heterogeneous is the deformation, it more important at the base of the breccia (locally in the clay layer).

Ultimately, our study suggests that the main slip plane has localized at the base of the breccia despite its induration. Thus we conclude that the Grand Ilet landslide is in fact a present-day reactivation of an old destabilization.