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Slope instability monitoring at the Piton des Neiges volcano (Reunion Island, Indian Ocean)

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Since the spectacular landslide of the northern flank of Mount St Helens, considerable attention has been focused on the unstable nature of volcanic edifices. Whilst most attention has been attracted by the gigantic debris avalanche deposits associated with many major active volcanoes, the less impressive aspects of slope instability have received less interest, despite this being one of the most important geo hazards associated with young volcanoes in terms of socio-economic costs.

Reunion Island, with an area of 2500 $km^2$and almost 1 million inhabitants, is affected by constant slope movement and huge landslides due to a combination of rugged topography (the Piton des Neiges volcano culminates at 3070 m), a tropical wet climate and a favorable geological context. This constitutes a serious hazard for inhabited sectors and affects private property, public infrastructure and land-management policies.

An important research project, funded by the European Commission as well as national and local agencies, has been conducted on the Piton des Neiges volcano over the last three years with the aim of i) characterizing the nature and origin of slope movements and ii) improving our capacity to monitor and predict their evolution over the coming decades. This study involved 1:10,000-scale geological mapping and isotopic dating, GPS and leveling monitoring, and radar interferometry.

Detailed 1:10,000-scale geological mapping of the slopes of the Piton des Neiges volcano has shown the influence of gravity-induced mass movements on its morphological evolution. The volcano is characterized by three large erosion features called

'cirques' that penetrate deeply into the core of the volcano and are surrounded by steeply dipping subvertical cliffs of up to 1000 m. The bottom of the 'cirques' are covered by a thick pile of volcanic breccia that accumulated due to numerous slow to fast mass movements ranging from rockfalls to flank failure involving volumes of more than several km^3 of material. Torrential erosion of the breccia by the deeply incised rivers results in a slow down-slope creep of the deposits above the impermeable and weathered volcanic basement and the redistribution of mass by debris flow. Carbon 14 dating of the organic matter preserved at the base and top of several large landslides has revealed their very young age (less than 10,000 years BP) and the necessity for continuous monitoring of the inhabited areas.

A GPS and leveling network covering the Piton des Neiges volcano has been installed as part of this project and several active landslides (Hell-bourg, Grand Ilet) have been monitored in detail. These populated areas are characterized by displacement vectors that can reach 1m/year and affecting areas of several km^2.

Space radar interferometry showed displacement rates of several cm/month for several landslides, which is consistent with the GPS and leveling measurements. However, the space imagery provides a better delineation of the landslide area by giving a synoptic view of the phenomenon.

The initial results obtained on this on-going project reveal a moving landscape and the necessity for continuous monitoring of the principal populated areas.