



Dyke and sill injections: what mostly trigger volcano flank collapse?

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There is a large number of evidences that the morphostructural evolution of basaltic oceanic volcanoes (e.g. Stromboli, Hawaï and Canary Islands) results of alternating phases of growth and destruction. Among dismantling processes, flank collapses have been largely documented and interpreted as gravitational destabilization triggered by vertical injections of magma (dykes). In most cases, this interpretation has not been sustained by field observations because active volcanoes have poor occurrence of outcropped intrusions. From this point of view, Piton des Neiges volcano (La Réunion Island) represents a case in point because it has been deeply incised by erosion, providing large outcropped surfaces exhibiting the geometrical relationship between intrusions and host volcanic formations. The recent discovery of a highly deformed pile of sills at the interface between a debris avalanche deposit and a fossilized magma chamber brought to light the role of horizontal injections in the triggering of lateral collapses. The validation of this assumption rests on a digital model developed from the Mixed Boundary Element Method of elastic deformation field analysis. In this study, we modelled the intensity and the distribution of deformation and Coulomb stresses perturbation due to the injection of dykes along rift zones and a sill below the flank of a basaltic volcano. We quantified the influence of the intrusions in the mechanical state of the edifice, based on the deformation detected during an intrusion of magma at Piton de la Fournaise volcano. By comparing the deformation generated by sills to that generated by dykes, our modelling approach concludes that the area deformed by a sill injection is much wider than that deformed by a dyke injection. Moreover, we found that sill injection reaches higher intensities of lateral displacements. The combination of field data and our modelling results suggests therefore that repeated sill injection is an underestimated trigger of large scale lateral failures. If so, sill injection has major implications in the morphostructural evolution of basaltic volcanoes.