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Asymmetrical deformation of the Piton de la Fournaise (Réunion Island) summit cone

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Piton de la Fournaise (Reunion Island) is an active basaltic shield volcano in the south-western part of the Indian Ocean. The activity consists essentially of lava being issued from two rift zones close to the summit cone. The summit cone has been monitored since 1980 by the OVPF (Volcanological Observatory of Piton de la Fournaise). Geodetic data and radar interferometry show a systematic asymmetric pattern of deformation associated with all the N-S trending eruptive fissures (Briole et al, 1998, Sigmundsson et al, 1999).

The asymmetric deformation has been interpreted in various ways. The two main models proposed are (1) the eastward dipping of the dykes, based on inversion of data provided by radar interferometry (Sigmundsson et al, 1999), and (2) the existence of a free boundary in the east part of the volcano. The second model allows the accommodation of dykes by eastward displacements, whilst the western part of the volcano is being support by the existing Piton des Neiges (Lénat et al, 1989). However, no displacements occur along the eastern coastline of Piton de la Fournaise. The only parts of the volcano affected by deformation are the rift zones and the summit cone. Moreover, geodetic data provided by the new real-time GPS network show, prior to eruption, there is an asymmetric deformation of the summit cone (Staudacher, 2005). The deformation itself seems to be related to pressure increase in the magma chamber. Absence of permanent displacements during periods of rest (such as 1992-1998) (Briole et al, 1998) support this link between magmatic activity and deformation.

Here we complement previous deformation studies by the results of several numerical models that aim at understanding the processes resulting in deformation of the volcano. By considering the lateral heterogeneity of the volcano, we are able to obtain an asymmetric deformation as resulting from (1) the asymmetric topography of the volcano, and (2) the existence of zones of weakness such as rift zones. The main deformation during eruptions or intrusions is due to excess pressure in the magma chamber and the overpressured dykes.

Our models explain the asymmetric deformation observed during eruptions as well as during intrusions. Absence of deformation on the other parts of the volcano, especially the lower eastern part, implies that stresses concentrate primarily in the eastern flank.

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