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Mode of deformation of basaltic shield volcanoes as exemplified by the Piton de la Fournaise volcano (La Réunion island): 1- Role of hydrothermal systems

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The Piton de la Fournaise volcano is one of the world's most active shield volcanoes. Analysis of its topography highlights two main structural features: (1) two sub-circular bulges which were previously interpreted as resulting from a combination of several events such as caldera collapse and flank landslides, and (2) a large U-shape structure (USS) which affects the volcano eastern flank. We carried out a detailed study of the bulge geometry which suggests that they formed nearly simultaneously between 65 and 4.5 ky ago. Numerical models were developed to understand the role of deep, thin and widespread hydrothermal systems in the low-rate deformation of a volcanic edifice. Results show that thin hydrothermal systems act as décollement levels on which the volcano upper part spreads. The volcanic spreading may create circular reverse faults in the volcano flanks and extension (i.e., normal faults) in the summit part). We apply the results to the Piton de la Fournaise and interpret the bulges development as induced by the two deep hydrothermal systems inferred in geophysics. Structural analysis of the USS shows that its formation was partly controlled by km-long faults which are still active. The most striking result inferred from the slope analysis and inspection of aerial photographs inside and outside the USS is that it results from a vertical collapse instead of a lateral landslide as it was always previously proposed for the Grand Brûlé. Although a role of the hydrothermal systems and other low strength layers of the Piton de la Fournaise and underlying Alizés volcano is suggested, the origin of this vertical collapse is still not fully understood.