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From permanent flank sliding to catastrophic collapse and explosive eruptions at basaltic volcanoes: the role of shallow intrusive magma bodies.

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Caldera collapses and flank failures, eventually associated with violent explosive eruptions, punctuate the history of volcanoes worldwide and represent major highly hazardous events in their evolution. Nevertheless, their link to magma transfer and storage in the plumbing system, together with the nature of weakness zones responsible for volcano collapses still need to be fully elucidated. We performed rapid decompression experiments on a set of basaltic rocks (lavas, dolerite dikes, gabbros) from Piton de la Fournaise, La Réunion, spanning a very large range of petrophysical properties. Samples derived from the most recent caldera-related explosive breccias of this volcano. Petrophysical measurements revealed a corresponding variability in density, porosity, P-wave velocity (dry and wet), and uniaxial compressive strength. The large variation in P-wave velocity and strength is interpreted to be the result of the wide ranges in texture (porosity/vesicularity) and lithology. Notably, some of the dense gabbroic units that have remained intact despite likely having experienced several natural cycles of heating and cooling are comparatively weak. We infer that volcano instability should not be interpreted solely in terms of altered rock units. On one side, the interface between shallow intrusive bodies and the vesicular lava pile represents a potential interface for repeated sill emplacement, which favour flank sliding. On the other side, weak shallow seated granular intrusive rocks with variable amounts of interstitial melt respond in a brittle fashion to rapid decompression during caldera and flank collapse events. The large petrophysical heterogeneity of crustal rocks together with the occurrence of shallow intrusive bodies must be considered when interpreting monitoring data and assessing potential hazards related to the stability of basaltic volcanoes.