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Interpretation of Elastic-Deformation Sources related to Volcano Deflation: insights from Distinct Element Method modelling

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Volcanoes commonly inflate or deflate during episodes of unrest or eruption. Continuum mechanics models that assume linear elastic deformation of the Earth's crust are routinely used to invert the observed ground motions. The source(s) of deformation in such models are generally interpreted in terms of magma bodies or pathways, and thus form a basis for hazard assessment and mitigation. Using discontinuum mechanics models, we show how host-rock fracturing (i.e. non-elastic deformation) during drainage of a magma body can progressively change the shape and depth of an elastic-deformation source. We argue that this effect explains the marked spatio-temporal changes in source model attributes inferred for the March-April 2007 eruption of Piton de la Fournaise volcano, La Reunion. We find that pronounced deflation-related host-rock fracturing can: (1) yield inclined source model geometries for a horizontal magma body; (2) at least partly explain underestimation by elastic–deformation sources of changes in sub-surface magma volume; and (3) cause significant upward migration of an elastic-deformation source, leading to underestimation of the true magma body depth and potentially to a misinterpretation of ascending magma.