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Internal flank deformation on large volcanic islands: comparison between gravitational spreading and rift zone intrusion through analogue modelling.

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Large volcanic islands are often structurally unstable and subject to seismic or aseismic deformation. For instance, the south flank of Kilauea volcano (Hawaii) is displaced during stages of eruption, and also during intereruptive stages. The east flank of Piton de La Fournaise (La Réunion) is displaced only during eruptive stages. These displacements are thought to be related to two principal interplaying factors: a) gravitational spreading along a subhorizontal detachment, and b) forceful intrusions into the rift zone and lateral widening. Using analogue experiments we study the influence of volcanic spreading and intrusion on the internal deformation of volcanic island flanks.

We used a granular material (sand) to represent the volcanic cone and a viscous material (silicone) to represent magma intrusion and a basal detachment. We performed systematic sets of experiments and study developing structures (a) during pure spreading, (b) during rift-zone intrusion, and (c) during spreading and rifting. The use of a glass tank permits a cross section view of the ridge, we thus could record the internal deformation of each experiment by using the Particle Image Velocimetry (PIV) technique. Optical images are analyzed by pixel-correlation, which enables to accurately measure millimeter displacements. Thus, obtained data covers the complete range of structural evolution and strain localisation that occurred in our models.

Our experiments show that both, (a) pure spreading or (b) forceful intrusion, encourage wedge internal faulting. Typical spreading structures are a basal sub-horizontal detachment together with a set of listric normal fault. Typical intrusion structures are a half-graben above the intrusion plus a sub-horizontal detachment depending of the intrusion depth. Because the types of faulting during (a) pure spreading and (b) rifting are dissimilar, we can now better identify the main mechanism of flank instability, flank faulting, and sector collapses on real volcanoes.