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Multiple magma emplacement and its effect on the superficial deformation: hints from analogue models

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To test the effect exerted by multiple magma emplacement on the deformation pattern, we have run analogue models with synchronous, as well as diachronous magma injection from different, aligned inlets. The distance between injection points, as well as the activation in time of injection points was varied for each model.
Our model results show how the position and activation in time of injection points (which reproduce multiple magma batches in nature) strongly influence model evolution. In the case of synchronous injection at different inlets, the intrusions and associated surface deformation were elongated. Forced folds and annular bounding reverse faults were quite elliptical, and with the main axis of the elongated dome trending sub-parallel to the direction of the magma input points. Model results also indicate that the injection from multiple aligned sources could reproduce the same features of systems associated with planar feeder dikes, thereby suggesting that caution should be taken when trying to infer the feeding areas on the basis of the deformation features observed at the surface or in seismic profiles. Diachronous injection from different injection points showed that the deformation observed at surface does not necessarily reflect the location and/or geometry of their feeders. Most notably, these experiments suggest that coeval magma injection from different sources favor the lateral migration of magma rather than the vertical growth, promoting the development of laterally interconnected intrusions.
Recently, some authors (Magee et al., 2014, 2016; Schofield et al., 2015) have suggested that, based on seismic reflection data analysis, interconnected sills and inclined sheets can facilitate the transport of magma over great vertical distances and laterally for large distances. Intrusions and volcanoes fed by sill complexes may thus be laterally offset significantly from the melt source. Our model results strongly support these findings, by reproducing in the laboratory a strong lateral magma migration, and suggesting a possible mechanism. The models also confirmed that lateral magma migration could take place with little or no accompanying surface deformation.
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