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Repeated shallow deformation events at dome building volcanoes analysed with spotlight interferometry

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Deformation on the uppermost few hundred meters of steep sloped active volcanoes is challenging to study due to hazardous and difficult access, damage to in-situ monitoring stations, and harsh weather conditions. However, quantifying changes in the summit region allows identifying important underlying processes in the magma conduit, including degassing, crystallization, porosity changes and shear localization as well as changes in the fluid phase, which can lead to pressurization.

Here we present new results from Volcán de Colima, Mexico. Using high resolution radar interferometry observations we have identified multiple, short term deformation events occurring both during volcanic quiescence and in association with small-scale explosive activity in 2017. The deformation patterns derived from InSAR in 2017 are similar to those in early 2013 (Salzer et al. 2014 in http://doi.org/10.3389/feart.2014.00012) despite significant topographic and morphological upper edifice changes occurring during the time between the events. Also, no similar short-term deformation events were identified during the periods of strong explosive and extrusive activity between 2013 and late 2016.

Our observations suggest a shallow source mechanism which can re-establish at a similar depth after major volcanic eruptions and morphology changes, but requires a preceding period of volcanic quiescence. Deflation of the source may or may not be associated with explosive activity.

By comparing our high resolution InSAR observations to numerical and conceptual models, we tentatively propose that our observations of summit deformation at Volcán de Colima are linked to the interplay of time-varying permeability and pressure changes caused by the consolidation of overlying volcanic material as well as hydrothermal and/or magmatic activity. We explore this as well as alternative hypotheses using complementary seismic data and finite element deformation models.